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THE

FOUNDRY TRADE JOURNAL

AND PATTERN-MAKER.

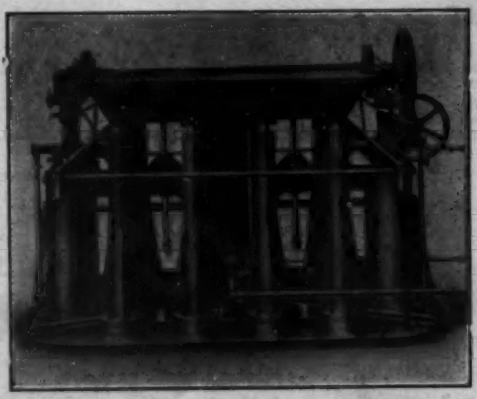
Vol. 21. No. 213. SEPTEMBER 1919. Price SIXPENCE Net.

JOHN MACDONALD & SON, LTD.

ENGINEERS,

WATT STREET, MARYHILL, GLASGOW.

"AJAX"
TURNOVER
JARRING
MOULDING
MACHINE.



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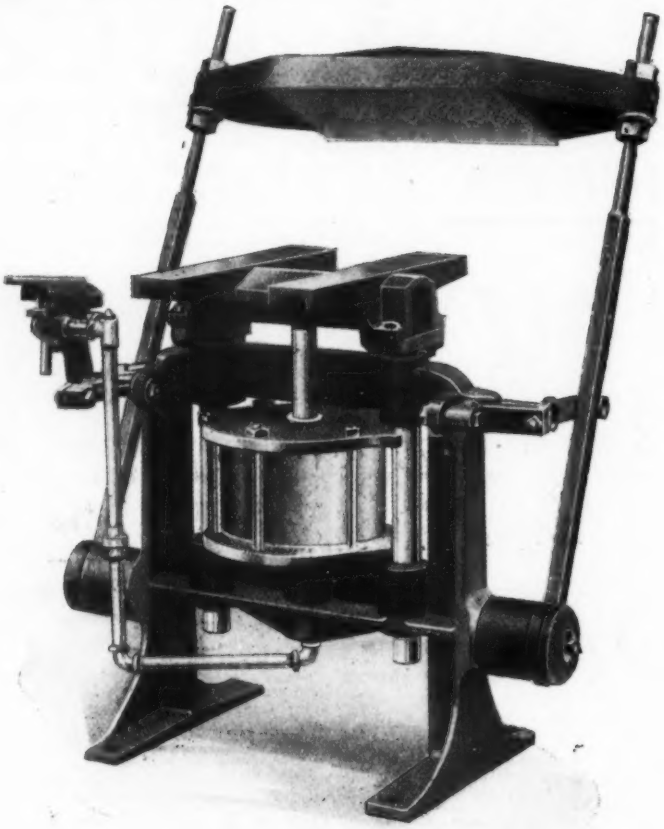

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25	"	" —	"	"	"	"	" —	.75
30	"	" —	"	"	"	"	" —	.70
35	"	" —	"	"	"	"	" —	.65
40	"	" —	"	"	"	"	" —	.60
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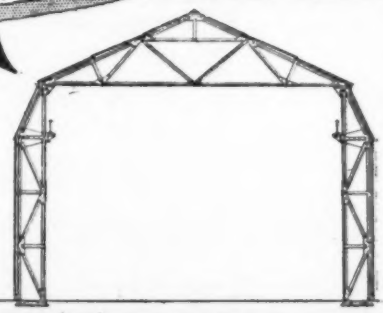

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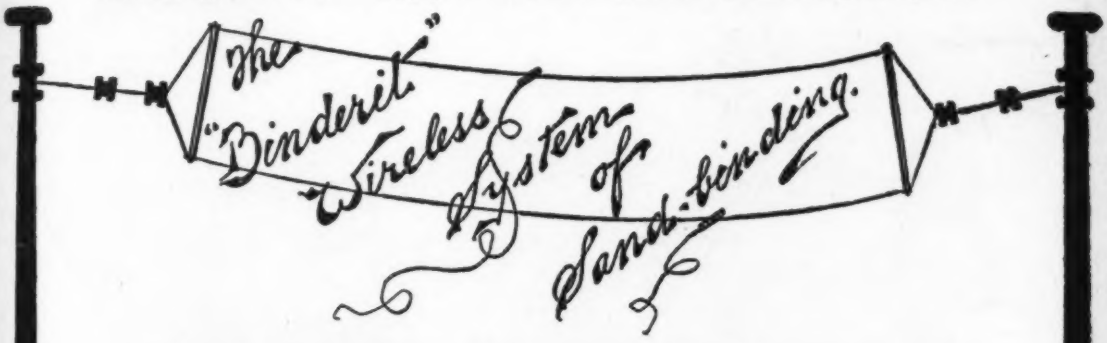

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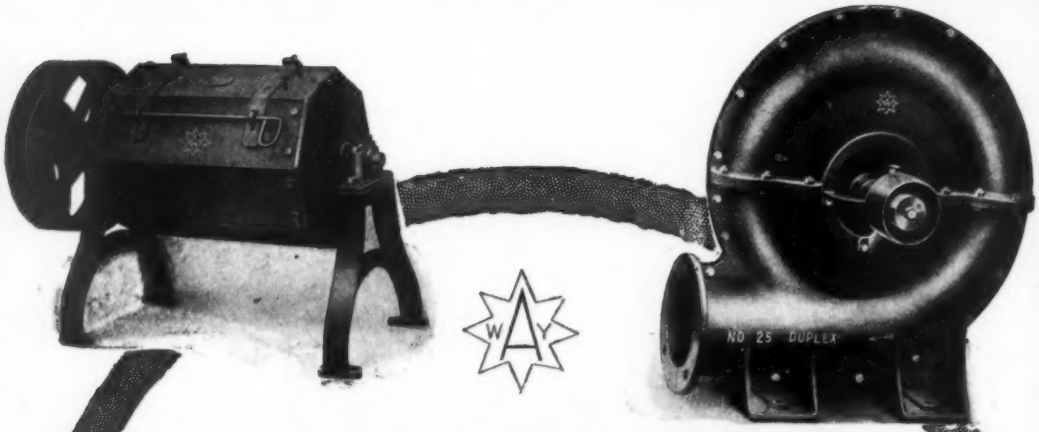

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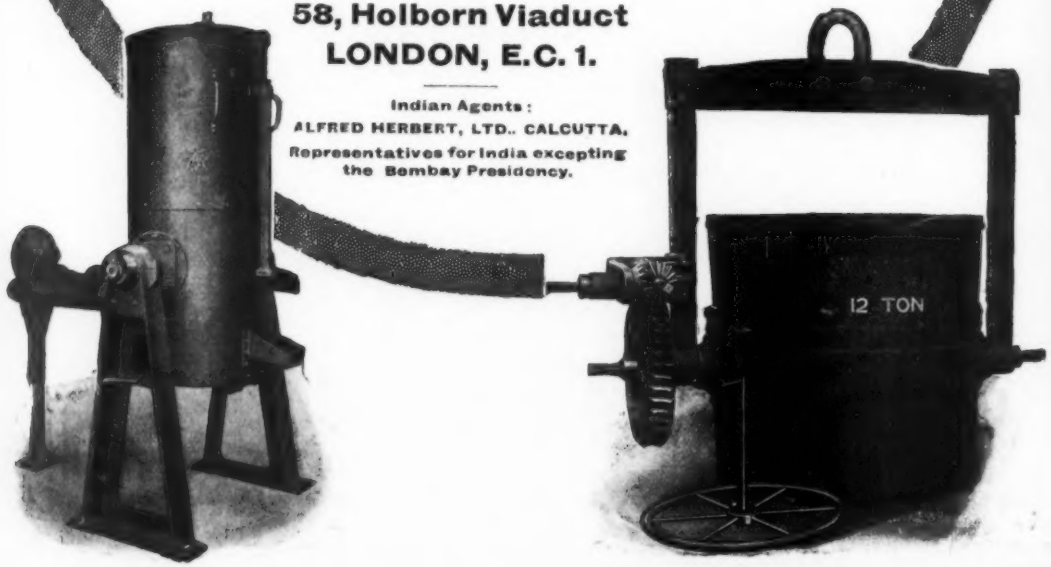

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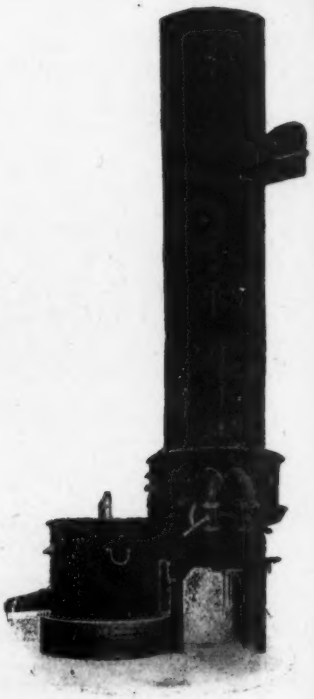

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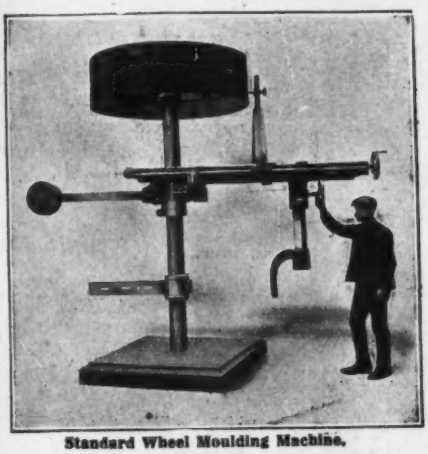

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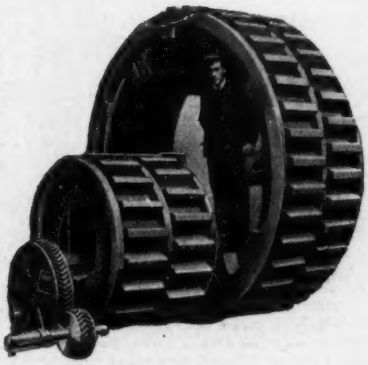
Complete Satisfaction Guaranteed



Wheels Moulded by this Machine.

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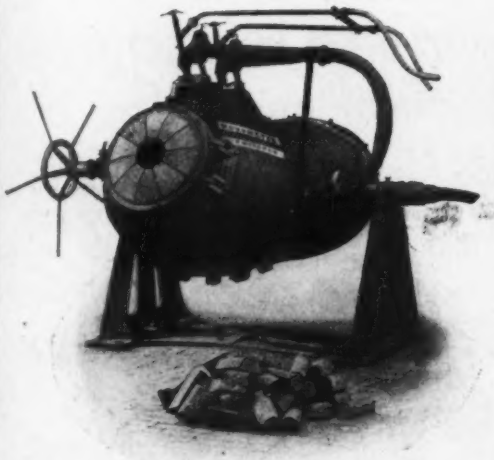

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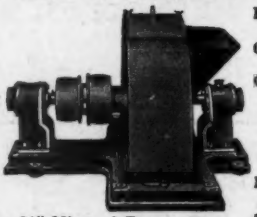

24" Mixer—3 Tons per Hour.

Fitted with Patent Roller Bearings, Renewable Reels, Grinds, Mixes, Screens & Prepares.

OLD AND NEW FOUNDRY SANDS AT LOWEST COST.

Saves Labour—Reduces Foundry Costs.

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4. All gearing is entirely enclosed as shown, therefore no metal can splash on to the gears.

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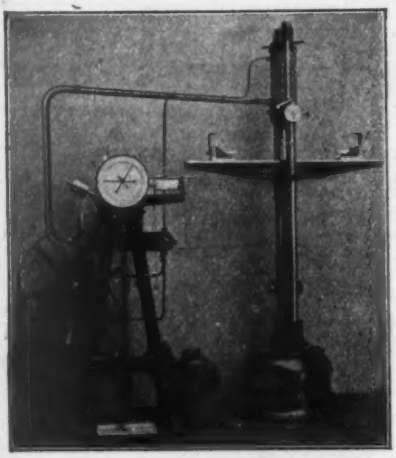

AMSLER TEN TONS UNIVERSAL TESTING MACHINE, arranged for TRANSVERSE TESTING, showing motor-driven oil pump mounted on the PENDULUM DYNAMOMETER frame.

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can supply from Stock all sizes from 10 to 100 tons capacity, operated by motor, belt or hand driven oil pump, to give tension, compression, bending, transverse, shearing and hardness tests.

The load is automatically balanced at every instant by a sensitive Pendulum Dynamometer.

The sensitiveness of the dynamometer can be instantly varied from full capacity to one-half, one-fifth, or one-tenth of the maximum load.

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The Foundry Trade Journal

AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN.

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Contents.

	PAGE
Notes and Comments	621
Death of Andrew Carnegie	623
The Practical Use of Denseners and Permanent Moulds	624
Loughborough Technical College Instructional Factory	630
Ministry of Munitions and its Influence on the Iron and Steel Trade	633
Castings Used in Ship Construction	635
Foundry Equipment	640
Cost of Electric Pig-Iron and Steel-Making Plant	641
Correspondence	642
Core-Box Construction	643
Welfare-Work in Factories and Workshops	646
A New Electric Rotating Brass Furnace	648
Properties and Preparations of Glues	652
After-War Effects of Two Conflicts	655
The Forming of Graphite in Iron-Carbon Alloys	656
The Coolidge X-Ray Tube	657
"Keep's Mechanical Analysis"	658
Loam-Moulding a Small-Diameter Fine-way Flanged Pipe	659
Moulding and Pouring Large Cast-Iron Dissolving Tanks	660
Defective Motor Castings	661
Heat Treatment of Aeroplane Parts	662
Moulding a Large Column in Loam	663
The Wedge Optical Pyrometer	665
Iron and Steel Production in Italy	674
Timber for Patternmaking	666
Trade Talk	667
Parliamentary Notes	670

Forthcoming Events.

SEPTEMBER 18 and 19.
Iron and Steel Institute:—Autumn meeting.
SEPTEMBER 24 and 25.
Institute of Metals:—Autumn meeting at Sheffield.
SEPTEMBER 25.
Shipping, Engineering and Machinery Exhibition:—At "Olympia," Addison Road Station. Opening of the Exhibition by the Right Hon. Lord Weir of Eastwood. The Exhibition will remain open for three weeks.

NOTES AND COMMENTS.

Invitation to British Foundrymen.

In connection with the great Inter-Allied Foundrymen's Convention and Exhibition to be held at Philadelphia from September 29 to October 3, Mr. A. O. Backert, president of the American Foundrymen's Association, has sent an invitation to members of the Institution of British Foundrymen, in which he says it is going to be the greatest gathering of grey iron, steel, malleable iron and non-ferrous casting manufacturers ever held anywhere in the world, and in a large measure it will serve to commemorate the peace just signed, and which has come over the world as the result of the defeat of the Central Powers. It is pointed out that this is not an international congress and exhibition, but an Inter-Allied Foundrymen's Congress and Exhibition, to which only the members of the industry who were allies during the war are invited. The exhibition of all kinds of labour-saving foundry machinery and equipment, machine tools and accessories, etc., which will be held in the Commercial Museum, Philadelphia, is going to be the largest operating machinery exhibit ever held in the country. The programme of technical papers, addresses, and discussions outlined by the technical department of the American Foundrymen's Association and the Institute of Metals Division of Mining Engineers will provide an opportunity to obtain information on the latest and best in American practice.

Research Organisations.

A conference of Research Organisations was held at the offices of the Board of Education, King Charles' Street, S.W., on Tuesday, July 29, the Rt. Hon. H. A. L. Fisher, M.P., in the chair, supported by Sir William S. McCormick, LL.D. (chairman of the Advisory Council), Sir Frank Heath, K.C.B. (secretary to the Department of Scientific and Industrial Research).

Those representing the engineering and allied industries included Mr. E. W. F. Fraser Smith (The North-East Coast Institution of Engineers and Shipbuilders), Sir William J. Jones, K.B.E. (British Refractories Research Association), Messrs. F. Tomlinson, Ernest A. Smith, H. L. Heathcote, Thos. Bolton (The British Non-Ferrous Metals Research Association), J. Bruce Harding and Walter Dixon (The British Iron Manufacturers' Puddling Research Association), H. L. Reason (The British Foundrymen's Association), and Sir T. K. Rose, D.Sc. (The Tin and Tungsten Research Board). Sir William McCormick (chairman of the Advisory Council) explained that the reason for calling the meeting was that certain matters had cropped up which would be better discussed than written about. Some of these matters had arisen from the side of the Associations, and some had been difficulties which the Government had felt, but he was sure they were matters on which they would like mutual enlightenment. The matters discussed were:—(1) The formation of a Records Bureau; (2) conditions of employment of research workers by Research Asso-

ciations; (3) co-operation amongst Research Associations; (4) subscriptions to Research Associations. At the close of the discussion Sir Frank Heath, K.C.B. (secretary of the Department of Scientific and Industrial Research) suggested in regard to a subsequent meeting that the representatives of Research Associations and other research organisations be asked to send matters for discussion.

British Engineering Standards Association.

The British Engineering Standards Association held its first general meeting on July 11, when SIR ARCHIBALD DENNY, BART. (Chairman), in presenting the report of the work in hand and contemplated, made a brief review of the position, in the course of which he said that the Association now numbered some 360 Committees and Panels, manned by about 1,200 members. The chief work at present in hand was the revision of the Standard Sections for Structural Steel, the standardisation of Aircraft Components, Automobile Parts, Electrical Machinery and Apparatus, Railway Materials, Machine Tools, Limit Gauges, Screw Threads, Shipbuilding Materials, and the details in the construction of ships and their machinery, and other miscellaneous subjects.

The Association was establishing, in a number of foreign countries and Overseas Dominions, Local Standards Committees of British engineers and traders in order to disseminate British Standards, and to assist British manufacturers in developing their foreign trade. A short report had been issued to subscribers to that particular section of the Association's activities, as well as to a large number of interested people and trade organisations, in order that they might have some details before them of the actual progress made, and consider to what extent they could still further associate themselves with the scheme and promote its success.

The Association had translated a number of its more important specifications into Spanish, Portuguese, Italian and French, and distributed them in considerable quantities to the various Local Committees. The Committees had been formed through the assistance of the Foreign Office and the Overseas Department of the Board of Trade, who had placed the services of the Consular Officers, Commercial Attachés, and Board of Trade Commissioners, at the disposal of the Association. The Government had subscribed £10,000 in support of the work, industry generally having subscribed some £14,000.

So far as the Dominions were concerned, the South African Engineering Standards Committee had agreed to act as the representative Committee of the Association in the Dominion. The Canadian Committee was acting as the Association's representative in Canada. In Australia an Engineering Standards Committee was on the point of formation.

Engineering Standards Committees were now being formed on similar lines to those of the Association in various foreign countries, the British Engineering Standards Association having been consulted in practically every case. The question of Anglo-American co-operation in particular had been considered in some detail. On the Continent various efforts had been made from time to time towards the formation of an international body for Engineering Standards, but it was felt that the time was scarcely ripe for such action.

In regard to the adoption of Standards, there was no doubt that British Standards would be employed to a far wider degree than ever before. Constant demands for standardisation were coming from various Government Departments as well as from powerful industrial organisations, and there was a general feeling that some steps must be taken to encourage the use of British Standards officially throughout the country by the Government departments, municipalities, corporations, and by all specifying engineers.

Iron and Steel Institute.

The autumn meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on September 18 and 19 next, commencing on Thursday at 10.30 a.m. and on Friday at 10 a.m. The following is a programme of the proceedings:—

Thursday, September 18.

10.30 a.m.—General meeting of members—Scrutineers will be appointed for the examination of voting papers for election of new members and associates. Award of the Bessemer Medal for 1919 to Professor Cav. Federico Giolitti, Ph.D., of Turin.

11 a.m.—General Conference on Fuel Economy.—A general conference on fuel economy will be held under the auspices of Committee No. 1 on Fuel and Ores at which the following reports and papers will be read:—(1) Report on Fuel Economy in Steel Works," by Dr. W. A. Bone, Sir Robert Hadfield, Part., and Mr. A. Hutchinson (presented on behalf of the British Association Fuel Economy Committee). (2) "Report on Fuel Economy in Foundry Practice," by Mr. H. J. Yates. (3) A paper on "Fuel Economy in German Iron and Steel Works," by Messrs. Cosmo Johns and L. Ennis.

The meeting will be adjourned at 1 p.m. till 2.30 p.m.

Friday, September 19.

10 a.m.—General meeting of members.—Papers Nos. 10, 13 and 4 will be read and discussed.

2.30 p.m.—Afternoon Session.—Papers Nos. 1, 11, 6, 9, and 8 will be read and discussed.

The following is a list of papers that are expected to be submitted:—(1) "Nickel Chrome Forgings," by J. H. Andrew, J. N. Greenwood and G. W. Green; (2) "Report on Fuel Economy in Steel Works," by W. A. Bone, Sir R. A. Hadfield, Bart., and A. Hutchinson (with a Supplementary Report by H. J. Yates on "Fuel Economy in Foundry Practice"); (3) "Decarburisation of Steel," by E. D. Campbell; (4) "On the Woody Structure of the Fractures of Transverse Test Pieces from Special Steels," by J. J. Cohade; (5) "Fuel Economy in German Iron and Steel Works," by Cosmo Johns and L. Ennis; (6) "Temper Brittleness of Nickel-Chrome Steel," by R. H. Greaves; (7) "Nature of the A1 Transformation and a Theory of Quenching," by K. Honda; (8) "On the Cause of Irreversibility in Nickel Steels," by K. Honda and H. Takagi; (9) "Experiments with Nickel Steels," by N. Hudson; (10) "Synthetic Cast Iron," by C. A. Keller; (11) "Brittleness in Nickel-Chrome and other Steels," by F. Rogers; (12) "On the Structure of Iron-Carbon-Chromium Alloys," by T. Murakami; (13) "The Fluxing Action of Iron Oxides on Acid Furnace Structures," by J. H. Whiteley and A. F. Hallimond.

James Watt Centenary Commemoration.

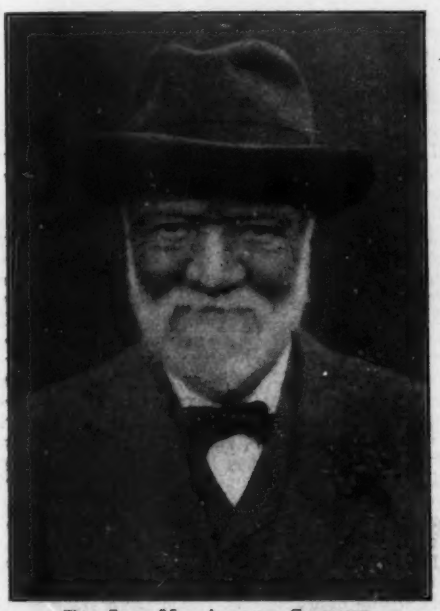
Arrangements have been made to commemorate the James Watt Centenary in Birmingham. An influential Local Committee has been formed and the provisional programme provides for the holding of a civic reception, a memorial service at Handsworth, visits to places of interest connected with Watt, a Degree Congregation at the Birmingham University, a garden party, a dinner, and a series of memorial lectures. The proceedings will commence on September 16. Members of the Iron and Steel Institute are specially invited to attend the Commemoration, but as the number of tickets available is strictly limited, and the attendance is likely to be large, early application is advisable. Those desirous of taking part should communicate at once with the Hon. Secretary, James Watt Centenary Committee, Chamber of Commerce Buildings, New Street, Birmingham, to whom all communications should be made direct.

Death of Mr. Andrew Carnegie.

We regret to announce the death of Mr. Andrew Carnegie.

Of the early years of his life little need be said, for the rise to fame and fortune of the Scottish bobbin boy has been faithfully chronicled for the benefit of the younger generation. The family emigrated to America in 1848, but it was not until some years after that he became associated with the American iron trade. In turn, bobbin boy, telegraph messenger and telegraph operator, he rapidly initiated himself into the business life of Pittsburgh.

It happened about the year 1863 that the Pennsylvania Railway Company decided to supersede their wooden railway bridge by iron structures, and the first bridge to be changed was the one at Pittsburgh, which was under Carnegie's control. This was his first great opportunity. He saw that iron was destined to supplant wood for bridges, and he resolved,



THE LATE MR. ANDREW CARNEGIE.

if possible, to be a leader in this great work of transformation. He took the step of proposing to undertake the iron bridge-work for his railway company, and the result was the establishment under his direction of the Keystone Bridge Ironworks at Pittsburgh.

This company was prosperous from its foundation, and a revolution in American engineering practice may be dated from its construction of the first iron bridges that spanned the Ohio River. The Union Iron Mills, his next venture, proved no less successful. In 1868 the rising ironmaster, now on the flood-tide of prosperity, paid a visit to England. Here he saw that the railway companies were substituting steel rails for iron. The Bessemer process had revolutionised the manufacture, and made this change possible. In regard to the value of the process, Mr. Carnegie was converted against his first judgment. It was one of the few errors he committed in the course of his phenomenally successful business career to oppose for some time the introduction of the Bessemer process, which had been strongly advocated by one of his partners. A timely visit to this country, however, quickly showed him how wrongly he had judged. He was shown the process in operation, and at once saw that it would revolutionise the industry. He acted immediately. Returning home, he formed a new combination to raise the required capital, and on a tract of more than a hundred acres, twelve miles from Pittsburgh, the famous Edgar Thomson Steel Works was launched upon its victorious career. Very soon he was turning out rails with which, and by the aid of high protective duties, he was able to compete with English manufacturers in the American market, and almost to dictate his own prices to the proprietors of the 200,000 miles of United States railways. The net result was that by 1888 Mr. Carnegie had bought out his rivals of the Homestead Works at Pittsburgh, and had acquired seven distinct works for the production of iron and steel, all within a radius of five miles of Pittsburgh, with an aggregate productive capacity of 140,000 tons of pig-iron per month and 160,000 tons of steel ingots.

It was in 1874 that Mr. Carnegie first began to draw the eyes of the world upon himself. In that year his new furnace, known as the Lucy, broke the record with a hundred tons, twice the average daily output of that time. The news was received everywhere with incredulity, but the fact could not be ignored that a new power had arisen in the industry. Henceforth the Carnegie Company had to be reckoned with. Their business continued to expand, and, in 1877 a second Lucy furnace was built, and both furnaces were operated by the company until the organisation of the Steel Trust. His business career ended with the formation in the spring of 1901 of the American Steel Trust. When that vast organisation was established, mainly by the efforts of the late Mr. J. Pierpont Morgan, the Carnegie properties formed its foundation. The new amalgamation was a natural development, a continuation of the policy which Mr. Morgan had so successfully carried out with regard to American railways. He knew little or nothing about iron or steel, but he saw that a combination of the several vast competing concerns then existing in the United States would be economically an enormous advantage to their proprietors; possibly the financier convinced himself that it would be a benefit to the American people. At any rate, having planned this mammoth undertaking in his mind, he formed the opinion that the one essential condition of success was to gain the support of Mr. Andrew Carnegie. This he succeeded in doing. This accomplished, he won over the ready assent of the following leading firms:—Federal Steel Company, capital, £40,000,000; American Steel and Wire Company, capital, £18,000,000; National Tube Company, capital £16,000,000; National Steel Company, capital £12,000,000; American Sheet Steel Company, capital £10,000,000; American Tin Plate Company, capital £10,000,000; American Steel Hoop Company, capital £6,000,000.

AMERICAN STATISTICS.—On September 1 last there were 6,444 foundries in the United States and Canada, a gain of 154 in two years, but Canada alone lost three in the period. In the preceding two years, however, the United States has shown a decrease of 44. The total number of exclusively non-ferrous metal-casting plants and brass and aluminium departments of grey iron, steel, and malleable foundries is 3,472—an increase of 25 in two years. Up to the present time most brass has been made in the United States in costly crucibles of imported clay and graphite. Since the war it has not been possible to import these materials, and manufacturers, it is stated, have had to put up with a very inferior brand at a cost many times over that of pre-war times. It is estimated that the avoidable losses in brass-making are more than $3,000,000 a year in normal times, and perhaps $10,000,000 in war times

The Practical Use of Denseners and Permanent Moulds.*

By E. H. Broughall, M.I.Mech.E.

It should first be explained that the writer is not dealing with the subject of denseners and permanent moulds from a scientific point of view. Some scientific information will necessarily be introduced; and such information, together with the accompanying tables have been supplied by our metallurgist, Mr. Handforth, who has been of great assistance in preparing the paper. With this exception, the following is simply a record of my practical experience and observations in connection with the use of denseners and permanent moulds.

It is to be regretted that foundrymen have given this most important subject such scant attention, the majority satisfying themselves by using denseners on the most simple castings. It is a subject which has huge possibilities, and opens up a way whereby far better products from the foundry can be obtained. In many instances, where it is practically impossible to get a sound casting by the usual methods of feeding, the problem becomes easy by the judicious use of proper denseners, or permanent moulds.

The use of denseners is not, of course, new. The author's experience of them goes back nearly twenty years, and the first instance he can remember of using them was in connection with the liner of the old Wolseley horizontal-cylinder motor-car engine. This particular engine cylinder, was made on the same lines as an ordinary gas engine cylinder, *i.e.*, with a liner which was inserted into a jacket casting: and it was in the making of this particular liner that the author first used denseners. The densener in this particular case was really a metal core. It is only fair to point out that these liners were cast with a densener to the instructions of the Wolseley Company, and, considering how long ago that was, the author thinks that great credit is due to whostrated the reasno of this improvement.

It is proposed to deal with this subject under two distinct headings: (1) the use of ordinary denseners for equalising the rate of cooling between a thick and thin portion of a casting, and (2) the use of permanent moulds for the production of sound castings, which are most difficult to produce by the ordinary moulding methods. The results of a series of tests will be given, which have been made in permanent moulds. Reference will also be made to experiments which, to some extent, have demonstrated the reason of this improvement.

As regards the use of the ordinary densener, it is, of course, understood that the necessity for denseners is caused through the uneven rate of cooling of thick and thin parts adjacent to each other. It is well-known that the slower the rate of cooling the greater the growth of the crystals. Moreover, a thin part adjacent to a thick part will, under ordinary circumstances, draw metal from the thick part owing to the quicker cooling of the thin part, leaving a spongey place at the junction of the two parts. To a great extent these troubles can be got over by the judicious use of denseners, which are simply intended to equalise as near as possible the rate of cooling between the slow-cooling thick part and the quick-cooling thin part; and it is important in designing a densener to make it of such dimensions that it will actually equalise, as near as possible, the cooling rates of thick and thin parts. If this is done, it is easy to see that it will be impossible for the thin part of the casting to draw metal from the thick part, because the thick part of the casting will be frozen at the point where the thin part joins, thus preventing the thin part drawing metal from the still molten thick part. In addition to this, the accelerated cooling of both parts densifies the metal.

In the use of denseners, it is of the utmost importance to have a ready means of checking the hardness of the mixtures used, and it must be clearly understood that it is not advisable to use denseners when using a hard mixture of iron, owing to the fact that in such mixtures is got something beyond density, *i.e.*, definite chill, which it is practically impossible to machine. It must, therefore, be appreciated that in using denseners generally, a careful check must be kept on the mixture of iron used.

In the first place, it is important that every consignment of pig-iron delivered should be chemically analysed, and a record kept of the result. Moreover, some means of easily checking the hardness of the mixture made, must be adopted. The readiest and most reliable means the author knows for doing this is by the well-known Keep's shrinkage test bar. This method has been in use by the author for many years. The necessary apparatus is simple to make, and the information derived from its use is of a most valuable character. By the use of this apparatus, the bars are chilled at the ends through coming in contact with a cast-iron yoke, and the amount of chill and shrinkage of the bar determines the hardness of the mixture so tested.*

It has been stated on several occasions that the hardness near a densener has been overcome by getting the densener away from the casting as soon as possible after casting, but the writer does not altogether agree with this. In cases where appreciable chill appears when a densener is employed, it is probable that a wrong mixture of iron has been used, and with a correct mixture the trouble of chilling would be almost non-existent. Moreover, in many cases it would be impossible to remove the denseners. If a correct mixture is used there is no danger whatever in leaving the denseners on the castings until the casting is cold. This was indicated by micrographs taken from 2 in. round bars cast in a permanent mould, the first of which was allowed to remain in the mould all night, while the second was withdrawn from the permanent mould as soon as the metal had set. To the eye there was no difference whatever between the fracture, nor was there the slightest difference between the cutting qualities of the two castings. As a matter of fact, however, a difference had really taken place, but this could only be detected by an

* Paper read before the Birmingham Branch of the Institute of British Foundrymen.

* Keep's "Cast Iron." Chapman and Hall, London.

examination of micrographs. This test was made on an ordinary soft iron, used regularly in permanent moulds, and the slight difference shown would probably be magnified considerably in a harder mixture of iron.

Up to fourteen years ago no denseners whatever were used in our foundries, and the introduction of them was caused through a considerable amount of trouble we were having with certain important

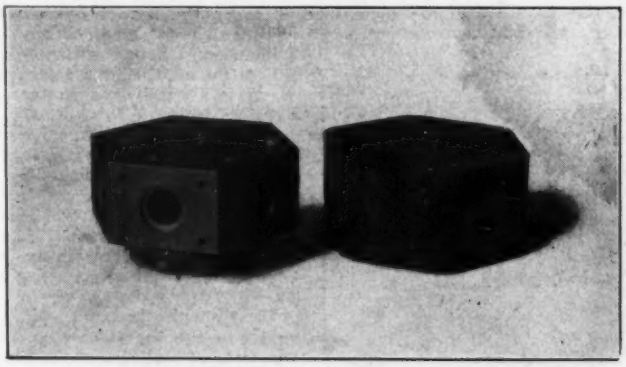


FIG. 1.—HEXAGON TURRET CAST IN PERMANENT MOULD.

castings. The first casting dealt with in this manner was an end cover for a feed pulley, having a very thin plate and a fairly thick boss adjacent. This cover was always on view in the finished machine, and it was most important that the casting should be clean and sound, but when the casting was made under ordinary conditions there was invariably a spongy place at the junction of the thin plate and the heavy boss. To get over this trouble a densener was used at the junction of the plate and boss. The writer well remembers what an exceedingly careful job was made of these particular densers. They were very carefully machined all over exactly to shape of the pattern. Subsequently, it has been found altogether unnecessary to machine denseners of this description, ordinary castings being used for the purpose. The use of the densener on this casting readily got over all the trouble we had been experiencing, and whereas our scrap of these castings had been very high indeed, it disappeared altogether when the denseners were introduced.

Another casting was also very difficult to produce by ordinary methods. In this casting four ½ in. holes were drilled through the centre, leaving only a very small wall of metal between each hole. The difficulty here was that the casting, having to be made solid, was always somewhat spongy in the centre, due to slow cooling and the formation of large crystals. The drill in passing through this spongy portion was drawn out of line, and invariably broke into the adjacent hole. This trouble was overcome by making this particular casting in a permanent mould.

Now there is hardly a casting we make without using a densener on some part of it, and hundreds of castings which it would be impossible for

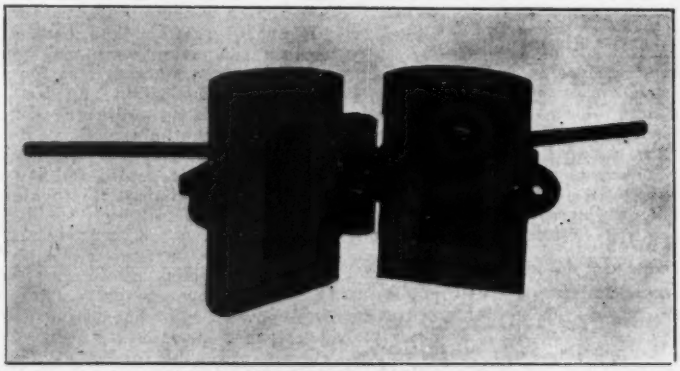


FIG. 2.—EXPERIMENTAL MOULD OPEN.

us to produce as sound as they are required, in sand moulds, are now easily produced in permanent moulds.

Another important use for denseners, besides equalising the cooling between thick and thin parts, is to densify certain parts of castings which form slides, such as the sliding surfaces of milling-machine bodies, knees and saddles, the ways of lathe beds, the sliding surfaces of lathe-bed saddles, etc. By doing this, not only are these surfaces pro-

duced sound and clean, but, owing to the density of the metal of these parts, considerable life is added to the machine, due to the exceedingly small amount of wear which takes place. In high-class machine tools, such as milling machines and turret lathes, this is a most important point, because if sliding surfaces, such as those mentioned, wear considerably, the alignments of the machine are upset, and accurate work becomes an impossibility.

As regards the metal from which denseners are made; it is our practice to use ordinary machine iron, but we do not use a densener more than two

FIG. 3.—EXPERIMENTAL MOULD WITH RECORDING APPARATUS.

or three times. Practically all our denseners are made on moulding machines at a very low cost, and, as the metal is our ordinary mixture, the denseners can be melted down after being used. Where it is required to use denseners for a considerable time, they should be made of a very hard iron; in fact, a correspondent in THE FOUNDRY TRADE JOURNAL, April, 1918, claims to get a very long life from his denseners, because he makes these of a very hard iron, and actually chills them.

Permanent Moulds.

It must be distinctly understood that there is an enormous difference between the use of a densener and the use of a permanent mould. As has been shown, the use of denseners locally simply accelerates and equalises the cooling between thick and thin portions of a casting, preventing porous patches, and at the same time densening the metal at the particular point where the densener is placed; but there is something in addition to all this when a permanent mould is used. With a permanent mould is got the advantage of the densener as regards the accelerated cooling of the metal, but, in addition, the benefit of an enormous amount of compression on the plastic casting. To this claim exception is, and probably will continue to be, taken. The author has, however, recently made experiments which go a long way to prove that this compression does actually take place. These will be discussed later.

As previously stated, permanent moulds properly designed will produce sound and close-grained castings which are impossible to produce in sand moulds. The author has seen the utmost care taken to produce certain castings sound in sand moulds, but without result. Feeding has been carried on most carefully for long periods, but the result obtained has been altogether unsatisfactory. However, by the use of permanent moulds, excellent castings have been obtained with a minimum amount of labour, and thoroughly sound throughout. One of the first castings we tackled in this way was a small hexagon turret used on our No. 4 capstan lathe. This, in its casting form, is a solid block of metal, hexagonal in shape, 10 in. across the flats, and 6 in. deep. This turret is machined all over, polished on the top, scraped on its six faces, bored from top to bottom for the turret post, and has a tool hole bored in the centre of each of the hexagonal faces, also a pad hole in each tool hole for holding the tool. It is of the utmost importance that every one of these holes be sound.

The difficulty in sand-made castings was that the centre of the turret casting, due to the extremely slow rate of cooling and formation of large crystals, was always porous. This meant that the hole for the turret post was never sound, and in most cases the tool holes were also porous. All this trouble was overcome by the use of a properly designed permanent mould, and since that time thousands of these turrets have been made without a waster. Fig. 1 shows the casting as made in a permanent mould, alongside the finished turret, and from this it will be seen that there are no less than thirteen holes which must be absolutely sound, besides numerous small holes and machined faces.

At one time the moulds for these castings were made in two halves, and connected by bolts and spring washers, but it was found that after a number of castings had been made in them, a certain amount of wear took place at the joint, which in time allowed room for a small fin. This fin caused considerable trouble, due to the fact that although an ordinary mixture of iron was being used, the fin cooled so suddenly that it was actually white, and this chill struck back into the casting a certain depth, and it was found that it was practically impossible to anneal this particular hard streak so that it could be machined.

Another form of permanent mould used for much larger turrets is simply covered by a sand top, which carries a runner and riser. A few minutes after casting, the sand top is removed, and the casting turned out. This description practically covers the use of all permanent moulds, and it may be added that one of the important things to watch in the designing of permanent moulds is to see that the casting may be easily turned out; also they should be massive enough to extract the heat from the molten metal in the quickest possible time. There should also be some allowance made for the mould to give a little at some point, as it is not commercially possible to make a permanent mould strong enough to entirely resist the enormous pressure which comes on the mould after the casting is poured. If this precaution is not taken it means that the permanent mould will, in time, either break or crack badly.

Another important point in the use of permanent moulds is to watch that the moulds are never used cold. Our practice is, never to let the moulds get cold. After using each day, they are put back into a core stove and kept warm ready for use the next day.

There have been many materials recommended for the dressing of permanent moulds, but we do not find that anything very special is necessary. We use a simple mixture of plumbago, oil, and treacle for wiping the mould over just before using; the addition of treacle is for the purpose of making the plumbago and oil stick to the surface of the mould. It is important to be sure that the surface of permanent moulds is not used in a rusty condition, as otherwise good results cannot possibly be obtained.

Amongst the many castings we make in permanent moulds, are round bars used for bushes and other small cylindrical parts. These bars are used in turret lathes exactly the same as a bar of steel would be used, and we consider a great saving is effected by this method, instead of using small castings. Our year's output of these bars approximately amounts to 200 tons. They are made at present in 4-ft. lengths, from 1½ in. to 4½ in. diameter. The moulds are carefully machined to size, and the joints tenoned. The two halves are held together by strong bolts carrying Grover spring washers. In a later type of bar mould, however, this mould has been carefully designed with a view to easy handling, and is closed and clamped quickly by the use of a toggle and lever. The bottom of the mould is closed with a dropping-bottom, easily operated by a small lever. The runner-box is also hinged and can be easily opened. This particular mould was designed in connection with the production of cast-iron fuse bodies from the bar. It is somewhat elaborate, but was designed for very large production; our instructions at the time were that no less than 1,000 tons of this material would be required per week.

Practical foundrymen will see that permanent moulds can be used on a large variety of work. It is not suggested that it is possible to make all sorts of castings in permanent moulds—a great deal, of course, depends on the shape of the castings required; but there are many castings used in the engineering trade which are very difficult indeed to get sound when made in sand moulds, but which can be made in permanent moulds without any signs of porosity. The author does not recommend, however, that it should be attempted to make small castings to shape in permanent moulds, he feels quite sure that these can be made much more successfully from round bar.

It is advisable that all castings made in permanent moulds should be annealed; not because they are chilled to any extent, as this will not happen if proper mixtures are used, but because there is almost sure to be a skin hardness which is probably only a few thousandths of an inch deep, and for machining purposes it is advisable to remove this.

TABLE I.

Sample.	Total carbon	Graphitic carbon	Combined carbon	Silicon.	Sulphur.	Phosphorus	Manganese.
Sand cast	3.272%	2.931	0.341	2.845	.068	1.075	0.51
Permanent-mould cast ...	3.272%	2.645	0.627	2.774	.081	1.060	0.49
Sand cast annealed* ...	3.272%	3.081	0.191	2.774	.077	1.075	0.50
Permanent mould annealed*	3.300%	3.190	0.110	2.774	.071	1.102	0.52

* Note method of annealing—Heated to 800 degrees C. for one hour and Cooled to 500 degrees C. in six hours.

The annealing may be done in an ordinary muffle furnace, and small castings should be closely packed in boxes with cast-iron borings. The furnace should be heated up to a temperature of about 800 deg. C., over a period of eight hours. At this temperature the furnace should be allowed to cool down, and the castings remain therein until black (hot). They may then be taken from the furnace and cooled in air whilst in the boxes.

It is, of course, well known that annealing does not improve the quality of sand-made castings. On the other hand, it considerably decreases their strength, as regards their resistance to compression. Dr. W. H. Hatfield, in "Cast Iron in the Light of Recent Research," says: "The annealing of grey iron inevitably leads to weakening of such material. When cementite is present this strengthens the material, particularly in compression. A comparatively short exposure between 750 deg. and 850 deg. C. is quite enough in foundry mixtures to precipitate this combined carbon from the cementite, and so leave the iron weaker than as cast." This argument, however, does not seem to apply in the case of iron made in permanent moulds, due probably to the entirely different physical condition of such iron as compared with sand-cast iron.

Besides the benefits already enumerated from the castings made in permanent moulds, another extremely important point as regards the machine shop, is the high speed at whch grey iron made in permanent moulds and annealed can be cut. The author has seen this material cut at the high speed

TABLE II.

Sample.	Transverse.		Tensile.	Compression.		Brinell No.
	Load in cwts	Deflection.	Max stress. Tons per sq. inch.	Decrease in length under 40 tons per sq. inch.	Load at fracture. Tons per sq. inch.	
Sand cast	23½	0.14in.	11.30	2.35%	50.12	170
Permanent mould	27½	0.10in.	15.22	.90	70.78	269
Sand cast annealed	24.0	0.14in.	10.96	9.61	47.1	149
Permanent mould annealed...	34½	0.15in.	17.40	1.0	71.44	217

of 300 ft. per minute, and it is quite usual to cut at 200 ft. per minute. The explanation put forward to account for this is that the combined carbon in the material is in a very fine condition, evenly distributed, through the casting. This, of course, has less effect on the cutting edge of the tool than if the combined carbon were in larger masses.

With regard to the physical difference between grey iron cast in permanent moulds and the same iron cast in sand moulds, there is no doubt whatever that iron cast in permanent moulds is considerably improved in all physical respects by this treatment. In order to illustrate this, a complete series of tests have been made on the same mixture of iron cast in permanent moulds and sand moulds.

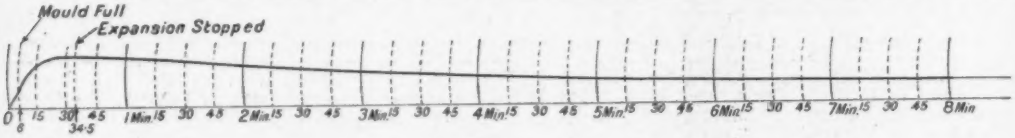


FIG. 4.

The method of testing was as follows:—Two bars, 1¼ in. square and 14 in. long, were cast in permanent moulds, and two in ordinary green-sand moulds; the bars were cast as quickly as possible from the same ladle of metal, the mixture used being an ordinary mixture for machine-tool castings. One bar cast in a permanent mould and one bar cast in sand mould were annealed by heating to 800 deg. C., for one hour, and cooled to 500 deg. C. in six hours. All four bars were then machined to exactly 1 in square. Transverse tests were made with the bars supported at 12 in. centres. Half of each bar was then taken and machined to a tensile test piece 0.564 in. diameter by 2½ in. parallel with screwed ends, and after the tensile test was completed, compression-test pieces were made from the tensile bars, 0.564 in. diameter by

Permanent Mould Cast.

FIG. 5.

½ in. long. Brinell hardness numbers were also taken and a drill-hardness test was made on each bar.

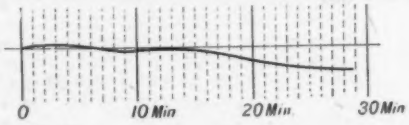
Chemical analyses were taken, and typical micro-photographs at 100 magnifications were made from portions of the tensile-test pieces, so as to get structures as nearly as possible related to the tensile tests. Table I. shows the chemical analyses of the various test bars used, and it will be noticed that the biggest difference found is in the combined carbon contents.

Table II. shows the results of the various physical tests, and these are a clear illustration of the great improvement brought about by the use of a permanent mould.

Although it is not advisable to place too much reliance on the Brinell hardness test for cast iron, it will be noted that the test bars cast in permanent moulds give a much higher Brinell number than those cast in sand, and it is safe to claim that this is additional proof of the extra density of the metal of the test bars cast in permanent moulds.

The above tests, the author thinks, conclusively prove that metal as cast in permanent moulds is considerably stronger in every respect than the same metal cast in sand. This superiority is emphasised in the tests from the annealed bars. The annealing, as carried out above, had little effect on the transverse or tensile strengths of the sand-cast bars, but caused a noticeable reduction in the resistance to compression. The same annealing had an entirely different effect on the permanent-mould castings. The resistance to compression is practically unaltered, but there is considerable increase in the transverse and tensile strength. The large deflection in the transverse test of the annealed permanent-mould bar is worth attention.

Micrographs of the two unannealed test bars, at 100 magnifications, taken from portions of the tensile-test pieces, showed intimate mixtures of ferrite, pearlite, graphite, and phosphide eutectic. The noticable differences were, first, that the permanent-mould cast bar contained more combined carbon than the sand-cast bar, and, secondly, that every constituent in the permanent-mould metal was in a much finer state of division than in the sand-cast metal. Micrographs of the annealed bars showed a ground mass of ferrite split up by flakes of graphite and phosphide eutectic. There was a distinct difference in the arrangement of the graphite, and it was probably due to this difference that the bars had such different physical properties. To illustrate the machining properties drill-hardness tests were made, which indicated



Sand Cast

FIG. 6.

very little difference between the hardness of the metal cast in the permanent mould and the sand-cast annealed bar.

In practice, however, we find that it is much easier to machine metal made in permanent moulds than the same metal cast in sand.

In conclusion, the author proposes to submit what he considers to be the cause of the various improvements in the physical condition of grey iron when cast in permanent moulds. First and foremost, it will not be disputed that this improvement is brought about to a great extent through the exceedingly quick cooling of the iron, which not only prevents segregation, but also prevents the formation of large crystals even at the centre of a large casting. There is, however, another action taking place, which is virtually a compressive force acting on the iron in its plastic condition, compressing the iron and consequently improving its density. In order to follow this theory, it is necessary to have some knowledge of the action which takes place when iron is cooling. To those who are not conver-

sant with this, the writer would recommend the study of Chapter VIII. of Keep's "Cast Iron." In this chapter it is clearly demonstrated that during the cooling of cast iron, three distinct expansions take place. Illustrations are given of these cooling curves, the whole of which refer to castings made in sand.

From experiments made for the purpose of this

FIG. 7.—PERMANENT-MOULD CASTING SHOWING EXTRUSIONS OF METAL.

Paper, it would seem that the cooling curve of metal cast in permanent moulds differs considerably from the curves of castings made in sand moulds. The author made experiments to prove this, the apparatus used being very similar to Keep's cooling-curve recorder. The curves obtained seem to indicate that the first expansion comes on much sooner and more definitely when the metal is cast in a permanent mould than it does in a sand mould.

The author's theory is that immediately the iron is poured into a permanent mould considerable and definite expansion of the iron takes place. In a sand mould this expansion has but little effect on the resultant casting, as the sand mould gives to the pressure, but in a permanent mould this expansion is resisted by the mould itself, and turned into a compressive force.

Following this, the outer shell of the casting to some considerable thickness immediately solidifies and quickly drops below the temperature of the third expansion. In this condition it is capable of resisting the second and third expansions of the metal as the permanent mould resisted the first expansion. All this resistance tends to put tremendous pressure on the castings, resulting in considerable density.

This theory has been criticised considerably, and up to the present the author has only been able to put forward in support of his contention the hundreds of observations he has made of metal being poured into permanent moulds. To prove this contention, however, he decided to attempt to produce definite proof that the theory submitted was correct. To do this a permanent mould was designed with a recording arrangement on it, whereby the expansion of the metal could be recorded through the movement of the permanent mould. Fig. 2 shows this experimental mould open, and Fig. 3 shows the same mould closed. The recording arrangement for recording the amount the mould opened, due to the expansion of the metal, can be readily understood. From this experiment, the author was enabled to produce a curve which he considers clearly establishes the fact that there does take place a considerable compressive force when metal is poured into a permanent mould.

Fig. 4 shows the curve that was obtained by this means, and it will be seen from this that immediately the metal entered the mould an expansion took place, which, in the particular instance under notice, continued for 34½ seconds. In ordinary practice this expansion would, of course, have been resisted by the permanent mould, and turned into compression. At this point the expansion stopped, and a gradual contraction followed for 4½ minutes, when no further movement of the permanent mould was recorded. At this stage, however, it is probable, as suggested above, that the outer shell of the casting had become sufficiently solid to resist the second and third expansions of the metal. A further experiment was carried out with, as stated above, an apparatus similar to Keep's cooling-curve recorder, and Figs. 5 and 6 show two cooling curves, one taken from a permanent mould and a sand-cast mould respectively.

In the cooling curve from the permanent mould it will be seen that a very definite expansion took place immediately the metal was poured, and this expansion was considerably greater than the first expansion in the sand-cast mould. Following on this expansion, the curve indicates that contraction took place, and one minute after pouring it would appear that this contraction was to some extent arrested; in fact, there is some sign that the second expansion took place at this period. It will be noted that no record was obtained of the third expansion, and this is probably due to the fact that the outer shell of the casting had become so rigid as to entirely resist the last expansion. In the cooling curve of the sand-cast bar, an expansion is distinctly seen at about twelve minutes after pouring. An important thing to note in these two curves is that general shrinkage in the casting made in a permanent mould occurred at about 1¼ minutes after pouring, whereas in the sand-cast mould this general shrinkage did not occur until about twenty minutes after pouring.

In order to further illustrate the enormous pressure which the author believes takes place when molten metal is poured into a permanent mould, Fig. 7 is of great interest, and shows a small casting 3 in. diam., 6 in. long, made in a permanent mould. It will be noticed that small pellets of metal have been extruded through the top of the casting. These pellets were forced through the solid crust of the casting two minutes after pouring, and this certainly indicates that a tremendous pressure was being exerted on the semi-plastic metal in the centre of the top of the casting. A micrograph of one of these pellets indicated a coarsely crystalline structure, and it was evident that the metal which was extruded contained a considerably higher phosphorus-content than the mother metal of which the casting was made.

Loughborough Technical College Instructional Factory.

The idea of combining in one institution the technical with a useful practical training has long been the aim of the idealist, but has hitherto been regarded as too Utopian to warrant any serious attempts being made to further the cause. We use the term "useful" advisedly, as we are aware that every technical school of any standing aims at imparting practical training. For obvious reasons, however, the scope of operations has been strictly limited, and the shops could not be regarded as productive; hence the instruction, wholly sound so far as it went, was not such as to turn out a practical commercial engineer. This, indeed, was recognised, a term at the technical school being followed by an apprenticeship at a works and the technical studies continued in the evenings, after the day's work in the shops.

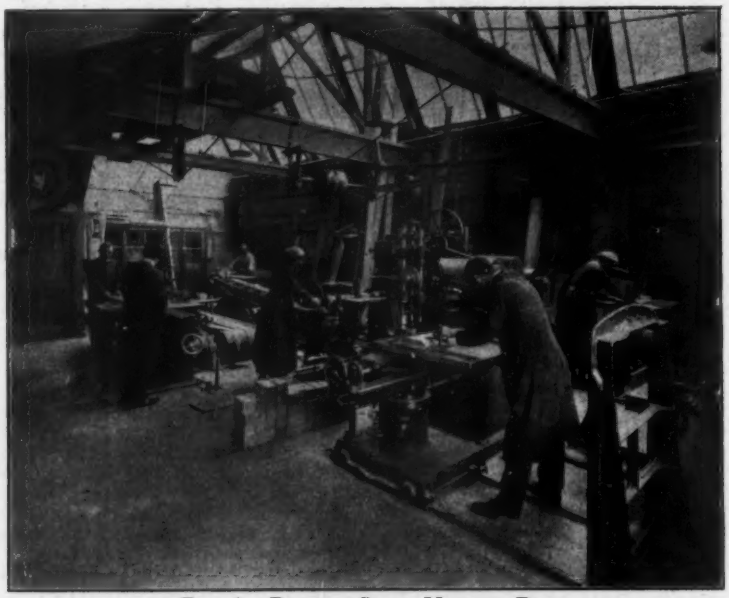


FIG. 1.—PATTERN SHOP; MACHINE BAY.

In the shop the boy is one of a number of apprentices to whom it is quite impossible to give individual attention and instruction, and, saving for the favoured few high-premiumed pupils, the scope of the apprentice in the shops will be confined to narrow limits. Under existing conditions, therefore, to the apprentice who wishes to make good, attendance at the evening classes of the technical school is an obligation, and in many respects an undesirable one. If the youth has done himself justice in the workshop, at the end of the day he is scarcely fitted to properly appreciate technical instruction, whilst the curtailment of the leisure hours so essential to the development of healthy manhood is to be deprecated.

It may be argued that if we make the technical school a productive institution we shall introduce an element of unfair competition. Such a contention, however, will not bear examination. In the first place, if the instructional factory is to perform its most useful functions, it is quite obvious there can be no continuity of operations, and therefore no possibility of economy of production; further, such an institution must maintain a large and highly trained staff, so that under the most favourable conditions productive costs cannot but be unduly high. In a word, as an actual productive concern the works must be run at a loss. The output would no doubt be absorbed by local engineering firms who might possibly hold some sort of control of the commercial side of the factory.

As an indication of what can be done in the direction referred to, we have an interesting and striking example in the Instructional Factory built in connection with the Loughborough Technical College. When in the early stages of the war there was a pressing demand for trained munition workers, and the Principal (Mr. H. Schofield, M.B.E., B.Sc., A.R.C.Sc., A.M.Inst.C.E.) was approached with the request that the engineering facilities of the College should be utilised to train women for one of the local shell factories, the engineering shop at the College occupied a floor space of 1,400 sq. ft., and the equipment consisted of four machine tools. Mr. Schofield entered enthusiastically into the matter, and immediately converted two of the larger class rooms into an engineering workshop, with an equipment of about 20 lathes, adapted for turning, boring, waving, profiling, etc. Contracts for

the production of shells were secured, and the turning of 4.5 and 18-pounder H.E. shells undertaken, thus introducing an entirely novel form of instruction, the women being trained upon production, and made familiar with the actual operations they would have to perform in the shell factory, and under practically the same conditions, as the rate of production closely corresponded with that obtained in the factory.

Later, the demand arose for large quantities of accurate gauges, and a department was added for the training of gauge-makers, though, as there was no space available in the College, a temporary building had to be erected for its accommodation, which, however, speedily gave place to a permanent building. This addition was fully justified by results, as the demand for trained gauge-makers, as also for flat, cylindrical and screw precision gauges, has at all times exceeded the capacity of the shop.

FIG. 2.—FOUNDRY.

Then followed almost immediately the erection and equipment of an automatic machine shop, a drawing office, pattern shop and foundry, the three last being incorporated into the same block of buildings, so as to preserve that close relationship between them which is so essential for the best results, alike in training as in factory practice. Next in order of sequence was the fitting out of workshops for the manufacture of aeroplane ribs, and the assembly of wings, ailerons, fuselages, etc.

At the time the original accommodation provided at the College was wholly inadequate to meet the demand for workmen. An entirely new block of buildings was therefore erected on the most modern lines, which was laid out for a heavy lathe shop, milling shop, smiths' shop, precision grinding shop, oxy-acetylene and electric welding shop, inspection and bond rooms, also general stores. A laboratory for testing and erection of aeroplane engines and a heat-treatment department were also built.

To meet the difficulty in finding lodgings for the increasing number of students, three residences in the better parts of the town were taken over and converted into hostels, whilst a suite of rooms formerly devoted to art were converted for social purposes, and comprised a club room, mess room, rest room, and also a well-equipped surgery, which last is in charge of a fully-qualified nurse.

In the installation of machine tools the aim of the management has been to arrange that all types should be represented, and that duplication of any type should, so far as possible, be avoided; the advantages of such an arrangement being that students are enabled to become familiar with the characteristics of machines of all types and at the same time acquire valuable information as to the relative advantages and disadvantages of each.

The pattern and aircraft woodwork shops include a timber store, saw mill, two rib shops and two assembling shops. The equipment consists of Wadkin's mechanical woodworker with attachments for cutting spur, bevel, mitre, helical, worm and spiral wheels; dovetailing, tennoning, spiral turning, panel raising, parallel and taper slotting, recessing, square and slot-morticing, chamfering and various core-box work. Wadkin's 7-in. × 3-in. four-cutter, 30-in. circular saw with rising table; 16-in. double-dimension circular saw with canting table; 20-in. surface planer and thicknesser, with canting front table and balanced guards; 9-in. panel

planer; 6-in. wood-turning lathe with travelling rack slide rest, and extended spindle, with face-plate for turning up to 4 ft. in dia.; 36-in. band saw with canting table and anti-friction guides; jig saw with canting table, 22-in. disc and 10-in. vertical reciprocating bobbin sander; vertical spindle moulder, with eccentric fence and two guards; vertical borer; hand morticing machine; capstan stand trimmer; bench trimmers, grinders, plane iron grinder, etc., etc. There is also an automatic band-saw setter, and a semi-automatic circular-saw setter.

The foundry is completely equipped for the production of all types of castings, large or small. the depth of sand varying from one to five feet in order that pit work may be undertaken. The melting plant comprises a 5-ton Whiting cupola, served by a hoist belt-driven from counter-shafting, and blast supplied by a Sirocco fan; a 1-ton Whiting tilting cupola, blown by a Sirocco fan; a 300-lb. Morgan gas-fired tilting crucible furnace; small high-pressure air-blast steel furnace; Wright gas-fired pit type aluminium furnace; two Carr crucible furnaces for brass, and a melting pot for low-temperature alloys. There is also a malleable-iron oven and two annealing furnaces for the heat-treatment of castings and steel. The auxiliary machines are of many various types, including Ajax & Mumford jolt ramming machines; Farwell adaptable and Pridmore moulding machines; oscillating sand-sifting machine; Alfred Herbert sand-mixing machine; tumbling barrel; sand-blast apparatus, and twin Norton grinder. Power for the pneumatic apparatus is supplied by an Ingersoll-Rand compressor.

The smiths' shop is served by a Herbert-Morris 2½-ton crane. There are two double hearths, a Utile blowpipe hearth and four anvils, and one small hearth for tool work. The forging plant comprises a 1-cwt. Alldays-and-Onions pneumatic hammer with electrically-driven compressor and belt-driven tilt hammer; the equipment further including a Meker hardening furnace for high-speed steel, and a Lumsden oscillating tool grinder.

The oxy-acetylene and electric welding shop has a very up-to-date equipment; the generators are placed in a separate building and the benches are so arranged in the shop that the fumes pass directly away from the operator. Ten blowpipes are attached at different points around the shop to the acetylene system, whilst provision is also made for using the acetylene on the high-pressure system. There is also a complete "Quasi-Arc" electric welding apparatus.

The heat-treatment laboratory, for the complete equipment of which Messrs. John Wright & Sons, Limited, Birmingham, were responsible, is provided with the most modern plant for the heat-treatment of high-speed and carbon steels, as also for the production of malleable castings. The plant includes two twin-chambered high-speed steel furnaces provided with a Féry radiation pyrometer, which comprises a single-thread recorder and a wall-pattern indicator; a Feusalt bath and thermometer. The carbon steel plant consists of two natural-draft oven furnaces; an open bath and thermometer, and a pyromelt bath furnace. For casehardening there is a cyanide hardening furnace and a natural-draft oven furnace. There is a tempering bath complete with thermometer, and a coke-fired furnace for the production of malleable castings, whilst a very complete and comprehensive pyrometer outfit is installed throughout the shop.

Further shops are devoted to sheet metal work, and finally the inspection department, where all manufactures are carefully viewed before being passed out of the works.

Power for the works is taken so far as possible from the town supply, but this has to be supplemented by the College plant, which consists of a Tangye 100-h.p. gas engine driving a B.T.H. generator. Pending the completion of the producer plant the engine is running on town gas.

During the period of the war the Factory trained no fewer than 1,355 women and 950 men.

HEAT TREATMENT FOR RAIL JOINTS.—A report made in 1915 by Mr. C. D. Young, then engineer of tests of the Pennsylvania Railroad, and submitted by the Rail Committee of the American Railway Engineering Association, concludes that plain angle bars, if heat-treated, can make a rail-joint having strength and efficiency equal to that of the solid rail. Heat-treatment, according to him, produces an increase in elastic limit ranging from 60 per cent. in solid 100-lb. rails to 79 and 150 per cent. in plain angle-bar joints with six and four bolt-holes respectively. In the rail the elastic limit was raised from 175,000 to 280,000 lbs., while in the bars it was raised from 70,000 and 50,000 lbs. to 125,000 lbs. in both cases. The treatment mentioned consisted in heating the material above the recalescence point (about 1,500 deg. Fah.), quenching in water, and then annealing the hardened steel at about 1,050 deg. Fah. The report also points out that a joint equal in efficiency to the solid rail can be obtained by heat treatment of some of the patented types of rail joints, or at less cost by a similar treatment of a special angle bar. The joint with this bar showed a strength at the elastic limit equal to that of the rail, and would cost less than the standard angle bar which had a strength of about 33 per cent that of the rail.

WELDING CYLINDRICAL BODIES. — A writer, in a recent issue of "Canadian Machinery," describes the difficulties usually encountered in welding cylindrical bodies. Seams, heads and bottoms of cylindrical bodies are considered in relation to welding practice, and the article also deals with the repair of flywheel rims and arms, engine beds, hydraulic cylinders, and similar duties of considerable difficulty. Attempts made to weld three fractures in a cast-iron boiler are described. The work was done with apparent success, but the repair soon gave out and the company had a new section fitted rather than go to further expense. A short fracture in a cast-iron hot-water circulating boiler was welded, but, when cooling, another fracture occurred with a loud report close to the weld, due to contraction stresses, and the section was then renewed. Similar welds were, however, carried out successfully later by the installation of a furnace in which the sections were first heated, then welded, and put back at once into the furnace to cool down very slowly. The cost was not more than the cost of a new section and was of use when new sections could not be readily obtained. In general, steel or wrought-iron boiler-welding repairs can be carried out to the common grooving of end plates over the furnace connections, and to defects in flue tubes and parts under compression, but not for parts under tension such as the cylindrical external shells. The author mentions attempts to weld a cracked gas engine jacket, a fractured breech end, a piston cracked at the back end, a lift hydraulic cylinder, and a longitudinally cracked gas-engine jacket, all of which were failures, as also the welding of a broken spur-wheel, an engine fly-wheel, and two cylinder heads. Other repairs were, however, successful, as for instance the jacket of a vertical gas-engine, the standard of a steam engine, and the flange and breech end of other gas-engines.

Ministry of Munitions and its Influence on the Iron and Steel Trade

(*Continued from page 577 August issue.*)

Scrap.

The fixing of prices for finished steel in 1916 at once affected the materials used in steel-making, and steps were taken on July 27 of that year to bring steel scrap within the scope of the Control Order.

A meeting of the leading scrap merchants was called by the Iron and Steel Department, and a preliminary discussion of the position of the supply and price of scrap took place. The result was the appointment of an Advisory Committee, composed of representatives of the principal firms. At first there was no shortage; but as time went on serious difficulties arose with regard to both supply and distribution. The movement of scrap prior to Government control had not been to any great extent direct from producer to consumer, but had passed through the intermediary of merchants, the business being largely speculative. The fixing of maximum prices interfered with operations of this nature, and was therefore regarded by a section of the merchant trade as a curtailment of legitimate business. Nevertheless, the great majority of responsible merchants accepted the position patriotically, and many of them showed every desire to help the Ministry over difficulties.

No statistics are available as to the total consumption of scrap by steel-makers prior to the war, or as to the amount of scrap used, but in general it probably did not exceed 30 per cent. of the charge, and in many cases was as low as 10 to 15 per cent. The shortage of pig-iron made it essential to utilise scrap to as great an extent as possible, and pressure was put upon steel-makers to increase the proportion up to 50 per cent. of the charge. To ensure this being done, each firm was requested to return the respective amounts of pig-iron and scrap used each month. After the first return the makers who were using only a small percentage of scrap were dealt with individually, and by this means after a few months a considerable saving in the consumption of pig-iron was effected. According to figures compiled by Mr. J. D. Stitt, who was in charge of the Section dealing with scrap iron and steel, the average consumption of scrap was raised during the war from 34 to 47 per cent. of the charge, thereby saving more than 750,000 tons of pig-iron per annum for the same ingot output. Under war conditions the normal sources of supply tended to disappear, but a new source became available as a consequence of the great programme of shell production which came into operation early in the war. This new supply consisted largely of steel turnings. So much of this material was available that steel-makers were quite unable to absorb it, and shell factories became blocked with accumulations. At first the only outlet was in the blast furnaces, and although many owners protested their inability to use turnings, under pressure they ultimately agreed to do so. Its use was so effective in increasing the output of pig-iron at a low cost that, at a later date, when steel-makers were able to absorb a greater percentage, the diversion to steel-works was objected to by blast-furnace owners.

During the greater part of the years 1917 and 1918 there was an insufficient supply of steel scrap to meet the needs of the steel-makers. In coping with this shortage, valuable assistance was given by the Salvage and Central Stores Department of the Ministry and by the Consultative Committee of Merchants in bringing into the market materials that hitherto had lain dormant throughout the country. Arrangements were also made with the Admiralty and with the War Office for putting into circulation all possible scrap materials, either in the dockyards or under the control of the Home Commands, and for bringing salvage material home from the battlefields in France.

Refractory Materials.

With the exception of magnesite there were ample supplies of refractory materials in this country at the outbreak of war, and the grinding and calcining plants then at work were capable of meeting the pre-war requirements of the steel-makers. This satisfactory position led manufacturers, who did not realise the increased demands that would eventually be made upon them, to encourage their younger, and in many cases best, employees to join the new armies. When first asked to increase their output they were able to respond by procuring and training additional labour; moreover, the majority of them had for a number of years been accustomed to carry large stocks; consequently they experienced no difficulty at first in meeting the increased demands. But early in 1916 it was realised that it would be necessary to take other measures to augment the output of refractories of all kinds; and for this purpose a Section of the Iron and Steel Department was created in July, 1916, under the administration of Mr. W. J. Jones. At first the Section dealt only with fireclay and ganister, but magnesite was taken over in November, 1916, and basic material in March, 1917.

Ganister and Silica.—These refractories, which are in great demand not only for steel-melting furnaces, but also for non-ferrous furnaces, the combustion chambers of gas retorts, etc., are produced in South Yorkshire, Wales and Weardale, and to a smaller extent in Scotland. The South Wales manufacturers are fortunate in having ample supplies of high-grade silica rock near at hand; while the South Yorkshire manufacturers have an excellent quality of ganister in the neighbourhood of their works. Owing, however, to a shortage of quarrymen the supply of Sheffield ganister was, early in the war, insufficient. It was sought to overcome this deficiency by grading and by mixing certain grades with a special stone quarried in North Yorkshire and North-West Durham (where the Knitsley Fell and Healyfield quarries were re-opened by the Ministry and worked by prisoner labour). As regards the quality of the material produced the results were not unsatisfactory. But the extensions to iron and steel works in progress in 1916 at length made the supply of high-grade silica goods totally inadequate, with consequent delay to construction; the maintenance of existing furnaces was even jeopardised, and this in some cases led to furnaces standing idle at a time when their output was most needed.

The total output of silica goods for July, 1916, with the works at their fullest capacity, was 7,966,000 "squares" of 9 in. × 4½ in × 2½ in., an output which was not equal to the requirements. To cope with the position it was decided to allocate the entire output to the steel-makers in proportion to their needs, and to restrict the use of first-grade bricks to steel-melting furnaces engaged upon war work, and to the vital parts of copper-smelting furnaces and of glass furnaces. The requirements of other furnaces were met by the use of second-quality bricks, of which there was at this stage no acute shortage.

At a meeting of the leading makers, held at the Ministry on November 8, 1916, further measures were concerted for increasing the output, and in spite of the

continued shortage of labour the output of silica and ganister bricks was by May, 1917, brought to a total of 10½ million bricks per month, at which figure it was maintained until the end of November, 1917. During this period provision had to be made not only for home requirements, but also for the needs of the Allies and of the new steel-works in India and Australia; shipments were also being made to Sweden to assist works engaged in the manufacture of special steels to the order of the Allies.

The production of silica bricks during the last three years of the war was as follows :—

1916 (estimated)	..	97,717,000 bricks
1917	..	122,465,000 ,,
1918	..	100,400,000 ,,

Magnesite.—Prior to the outbreak of war the magnesite-brick industry was almost wholly in the hands of the Austrians, who not only possessed in their own country extensive deposits peculiarly suited for brick-making, but had devoted both skill and money to the perfecting of their products, with the result that they commanded practically the entire custom of the steel trade of this country. One or two, at the most, of the British manufacturers had made small quantities of bricks from magnesite imported from Greece, but with little success.

On the outbreak of war energetic measures were at once required to make up for the loss of the Austrian material and to ensure an adequate supply to the manufacturers of basic steel. Arrangements were therefore entered into with a number of makers for the manufacture of magnesite bricks at an agreed selling price, subject to the Ministry arranging for the tonnage necessary for the shipment of the raw material to this country, the price being regulated from time to time in accordance with the c.i.f. cost of raw magnesite.

In the latter part of 1916 a great increase in the demand for magnesite bricks and cement was foreshadowed by the plans formulated by the Home Ore Supply Committee for an increased manufacture of basic iron. The total requirements for the year 1917, so far as could be foreseen on December 31, 1916, amounted in terms of raw magnesite to 102,000 tons. This amount was far greater than the consumption of any previous year.

Owing to the uncertainty of the political position in Greece during the latter part of 1916, it became necessary not only to obtain from this source without delay as large a quantity as possible, but also to make arrangements for other sources of supply in case this one should fail. Hitherto, practically the whole of the magnesite used in this country had been imported from the island of Eubœa, only a very limited tonnage being obtained from India.

Accordingly contracts for the first six months of 1917 were made : (1) with the Anglo-Greek Magnesite Company, for the whole of the output from their mines in Eubœa; (2) with the Magnesite Syndicate, for the whole of the output from their mines in Madras; and (3) with Messrs. Allatini Brothers, of Saloniki, for as much as they could supply from their mines in Yerakino. In all cases the Ministry had the option to continue the contract for the second half of 1917 on the same terms. Further, the local director of the Anglo-Greek Company was instructed to buy up all he could from small mines in Eubœa not owned by his company.

In view of a possible shortage other measures were also taken. An Order, dated January 9, 1917, was made by the Minister of Munitions prohibiting the use of magnesite and magnesite products for purposes not absolutely necessary, and for which substitutes could be found. Considerable economy in magnesite bricks was effected by inducing steel-makers to adopt a modification of the form of lining of their basic steel furnaces suggested by the Ministry. Further, in order to economise shipping space the French and Italian authorities, whose estimated requirements for 1917 were equivalent to 27,000 tons of raw magnesite, were persuaded to put down brick-making plants, so as to be in a position to provide for their own needs.

To deal effectively with the situation it was necessary for the Ministry to control both the import of magnesite to this country and its distribution after arrival; for this purpose it was arranged that Messrs. Tennants (Lancs.), Limited, Liverpool, should act as distributing and collecting agents.

The imports of magnesite for the years 1917 and 1918 were as follows :—

——	1917.	1918.
	Tons.	Tons.
Raw magnesite	65,369	39,930
Caustic calcined magnesite ...	4,570	1,424
Hard burnt magnesite ...	4,454	Nil
Dead burnt magnesite ...	6,414	447
Total equivalent raw...	95,045	43,672

The favourable development of the political situation in Greece had relieved the position to some extent, though the submarine activity of the enemy continued to be an adverse factor. By the end of 1917, however, 95,000 tons of raw magnesite had been safely landed in English ports; while the actual losses in transit incurred comprised seven cargoes, aggregating 23,744 tons. At the close of 1916 the stocks of magnesite in the country were equivalent to 52,508 tons of raw magnesite, or, say, six months' supply. On December 31, 1917, the total stocks in the country, after providing for the requirements of all the industries concerned, aggregated 82,945 tons.

The production, export and home consumption of magnesite bricks were as follows :—

——	1916.	1917.	1918.
	Bricks.	Bricks.	Bricks.
Production	5,307,270	5,813,924	3,981,342
Home consumption...	—	4,867,302	3,668,791
Export		946,622	312,551

Basic Material and Shrunk Dolomite.—"Basic material," as it is popularly termed, is prepared by the calcining, at a suitable temperature, of magnesian limestone, *i.e.*, dolomite, and is used for the preparation and the repair of the hearths of steel furnaces using the basic process of steel-making. Forty to forty-five tons of the shrunk stone are needed to form the hearth of a 50- to 60-ton furnace, while for maintenance purposes practically 1 cwt. is required for every ton of steel produced. Although at the beginning of the war only four firms were engaged in calcining the stone for steel-works purposes, they were able to cope with the demands made upon them until the latter part of 1916. During that year the aggregate average monthly output totalled 10,175 tons, and during the last two months of 1916 upwards of 11,000 tons of calcined dolomite were called for per month.

According to returns made to the Ministry of Munitions, the production of raw dolomite for the manufacture of basic material for the years 1917 and 1918 was as follows :—

	917	1918.
	Tons.	Tons.
Raw dolomite (used raw) ..	68,027	39,847
Shrunk dolomite	152,880	184,655
Total equivalent raw	373,787	409,157

(*Concluded.*)

Castings Used in Ship Construction.

MOULDING PROPELLER BRACKETS.—Part II.

By Ben Shaw and James Edgar.

Although the design of the propeller bracket shown in Figs. 1 to 5 resembles in some respects the one described in the last article, it differs from it in some important details. It is similar, because the section of the arms or fishbacks is the same, except that in the bracket under consideration they are not cored out, but are cast solid.

Sketches of the templates that would be supplied by the moulding lift are not given, because they would be similar to those supplied for the propeller bracket described in the last article. A template would be made for the arm-section, and it will be noticed that in this case the arm does not taper in thickness towards the palm, but is of uniform

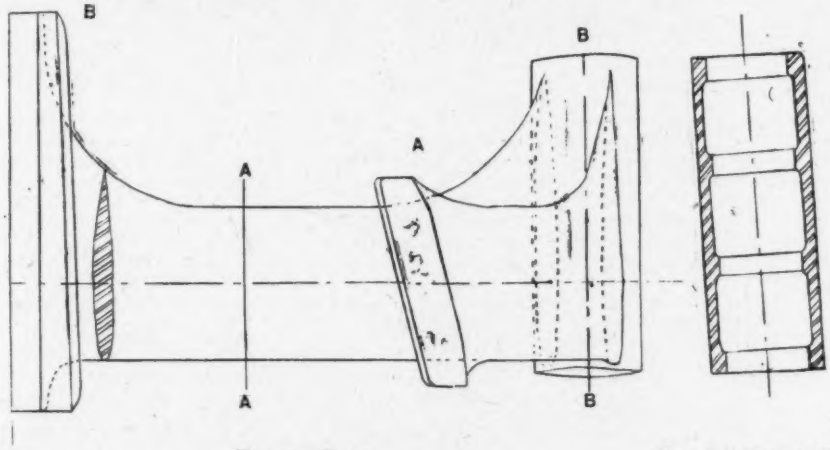


FIG. 1.—PLAN. FIG. 2.—SECTION B.B.

Sometimes these brackets are called "A" frames, because of their shape. It will be observed that the boss in this case is very long, and the palms are, of course, quite different. It might be possible to make the pattern for this bracket in a similar way to the one already described; that is, by building two mocks on the floor, and after the palms are finished, fitting the arms between them and the boss. But it would be a very clumsy task and it would be difficult to ensure accuracy, or to get a job sufficiently strongly built to stand the usage of the foundry. This is a bracket which it is possible to built in a position corresponding to that which it will take in the ship. Because of the angles of the arms in relation to the boss, and the angles of the palms in relation to the arms, the construction of the pattern requires great care, and it would be inadvisable, even when carried out by the most competent workmen, to allow it to go to the foundry without a very careful examination. It will give an idea of the difficulty of making these jobs when it is pointed out that the barrel for the boss is sometimes 25 ft. in length.

section throughout. The angle of the boss would be given by template, which would rectify any discrepancy between the drawing and ship, and the template would also be necessary for both shape and angles of the palms, while a large template would define the angles of the arms to each other. It is not necessary to set the job out in detail on the floor. The better way is to make full-size views of each arm on a drawing-board, and either set out centre-lines of arms and boss on a drawing-board or on the floor. It will be necessary, in order to economise when breaking out timber, to make scrap views of fillets, palms, and parts of the barrel. A watchful foreman can save a great deal of work of this kind, as only the best timber can be used on such work, and the importance of economising is great. The boss for this bracket being very long, it is necessary to provide for two lifting-bolts, and the stays (A, Fig. 6) should be made about 3 in. thick and 4 or 5 in. wide. The timber ought to be unwarped in the length, and placed perfectly straight, or it will be impossible to make a true barrel. It is good practice to break out all the

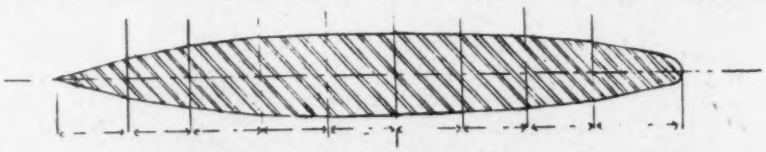


FIG. 3.—ENLARGED SECTION THROUGH A.A.

timber for such a job at the beginning, cutting it to approximately correct widths and thicknesses. Even a comparatively straight-grained board will change its shape when reduced in thickness or cut into widths, but if cut to the correct thicknesses and widths and allowed to lie for a day before being planed it will be permanently reliable. In some patternshops this is the charge-hand's work after he has set down the job, and apart from the saving in timber, it compels him to thoroughly master the details of the job at the beginning. It is not possible, however, to adopt this practice with some jobs, where every piece of timber has to be cut separately and fitted. The rings or grounds should not be more than 20 in. apart. As the lifting-bolts—usually 1¼-in. bolts—will drop down towards the outside of the barrel, special stays like B, Fig. 6, should be checked into the rings. They form guides for the bolts. It is unwise to rely on the stays while fastening the lagging when making such a heavy barrel. Cross centre-lines should be drawn on the rings, and the skeleton ought to be fixed on the floor with end triangular-frames (Figs. 7 and 8). It is a simple matter to screw straight-edges across the centre lines on each end, on which to try a level. It is necessary, of course, to pack one end-ring underneath, as each ring is of a different diameter owing to the taper of the barrel. A few diagonal stays are usually fitted inside the skeleton between the rings before the lagging, which ought to be 1½ in. or 2 in. thick, is screwed on. The lagging for such a job should be open-jointed, and when half of the barrel has been covered, the triangular frames can be safely removed and the remainder of the lagging fixed on.

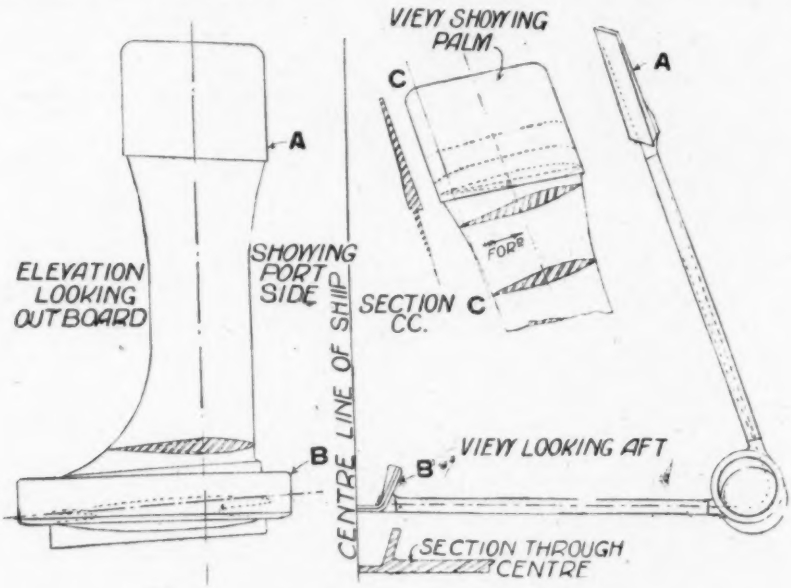


FIG. 4. FIG. 5.

The frames for the arms, Figs. 9 and 10, will differ from each other, because the palm A in Figs. 1, 4, and 5 is built on the centre-frame, while the palm B is made separately and dowelled on. It would make the fillets too unwieldy to complete them separately from the arms, but a better way is to form part of the fillet on the arm. The method suggested for fixing the arms is by means of hook-bolts, the hook gripping the frame of the arms, and the bolt penetrating to the inside of the barrel. Of course, a guide has to be formed for the arm, and this is done by making the frame act as a dowel into a recess in the fillet. The centre-frames should be stoutly made, and the portion of the boss-end which will be a dowel should be the depth of the part of the fillet which is fastened on the boss, and this ought to be 1 ft. or more in length, depending on that of the arm. The best way to build the arms is by pieces screwed

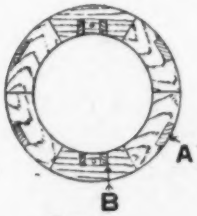


FIG. 6.

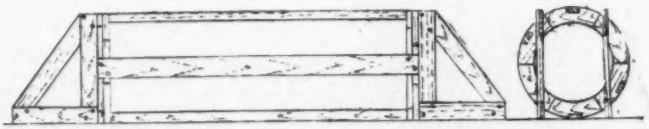


FIG. 7.—SKELETON OF BARREL WITH END FRAMES.

FIG. 8.

across the frame. Like those on the straight, they can be sawn and sand-papered to shape on a disc from a template. The fillet portions can be roughly sawn and finished off when the whole arm has been built. Although in the sketch (Fig. 10) the arm A is shown the full length, the actual length is determined by the edge view. Thus, in Fig. 12, it will be seen that the bevel on the back of the palm necessitates the frame being made short. It is long enough, however, to support the thickness pieces C, which have to be screwed on the face and left open-jointed. A portion of the

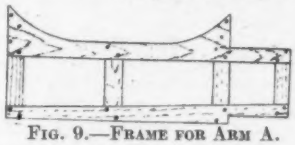


FIG. 9.—FRAME FOR ARM A.

face B, Figs. 11 and 12, has to be left loose, with a long taper at D, the purpose of which will be explained in a subsequent article. To complete the arms B, the flange or palm has to be quite finished and dowelled on. If a view like Fig. 13 is drawn, showing the shape on both ends of the palm and cross-lines, 1 in. apart, 1 in. timber can be used for constructing it, and each thickness quite finished before it is fastened on. This is both a

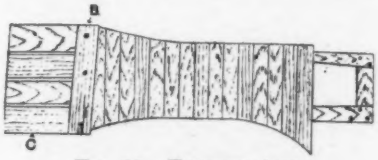


FIG. 11.—FINISHED ARM.

quicker and more accurate method than roughly building timber and shaping it finally. The face A, Fig. 14, which joins the arm, has to be planed, so that the angle of the palm will be correct, and care must also be taken when inserting the dowels. If centres are drawn on each face, there should not be any difficulty. It will no doubt be necessary to trim the edges when the palm is dowelled on, the latter being screwed as well as

FIG. 13.

FIG. 14.

dowelled to keep it rigidly in position, while the moulder is ramming the sand round it.

Building the fillet is the most arduous task of all. It has to be built in position on the barrel, and the finishing has to be done after the building is completed. The jointing of the timber depends greatly on the size and the shape of the fillet, and no hard and fast rule can be applied to all cases; it is wise, of course, to have the feather-edge of such fillets, where they join the barrel, with the end of the grain, as it must be remembered the fillets are not glued on, but have to be left loose, that is, with screws inserted which can be withdrawn, allowing the barrel to deliver from the sand. Screws may be put in temporarily from the outside, but after the fillets are built, and before they are cut, it will be more convenient to screw them from the inside of the barrel. This is quite easy, as the barrel being of large diameter a boy or man can get inside and use a turnscrew.

We shall pay attention to each fillet separately When the longitudinal centre-line of the barrel is set down on the floor, and a line, corresponding

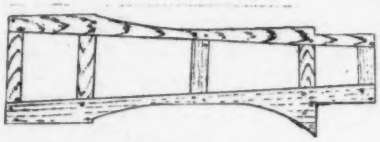


FIG. 10.—FRAME FOR ARM A.

to the face of the fillet is also drawn with the centre-line of the arm bisecting it, the barrel will have to be lifted on saddlepieces, so that the fillet can be built with a level centre. This is necessary because the cross-centres of the arms are not on the same plane as the horizontal centre of the boss. Fig. 17, which shows the arrangement for finally assembling the various parts, will give an idea of the arrangement for building the fillet. The saddle-pieces, A, are first screwed down, and the barrel rested on them and retained in its position by screws or battens on the ends. A table A, Figs. 15 and 16, has to be made for build-

FIG. 12.—SIDE VIEW OF ARM A.

ing the top part of the fillet, and the first piece of timber will correspond with the line of the top face of the arm-frame. This will ensure the recess for the dowel being correct. A rough outline of the

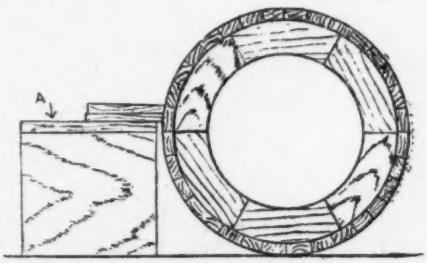


FIG. 15.

elliptical shape formed by the junction of the fillet with the barrel should be drawn on the latter. This is not a difficult matter, as width and length are given on the working drawing, and the shape between is largely a matter for the craftsman's judgment and artistic sense. The line for the face of the fillet should be squared from the floor to the top of the stave. In building the layers of timber for the fillets, glue should be used, as not many screws can be left in, while the shaping is being done. When the top of the fillet is built, the table should be removed. Two pieces, exactly the same thickness as the arm,

should form the layer, and the space between them will correspond with the width of the arm-dowel. The bottom can then be built similarly to the top. A great help in shaping the fillets is to make some short laths of very straight-grained pine about

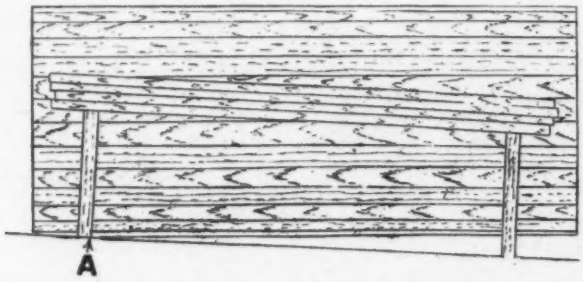


FIG. 16.—BARREL WITH FILLET PARTLY BUILT.

FIG. 18.—BARREL WITH FINISHED FILLET.

¼ in. square. This is better than relying wholly on sight and touch, as both hand and eye fail to detect slight flats and lumps after the craftsman has been working at the job for some time. Wherever the lath is tried on the fillet it should

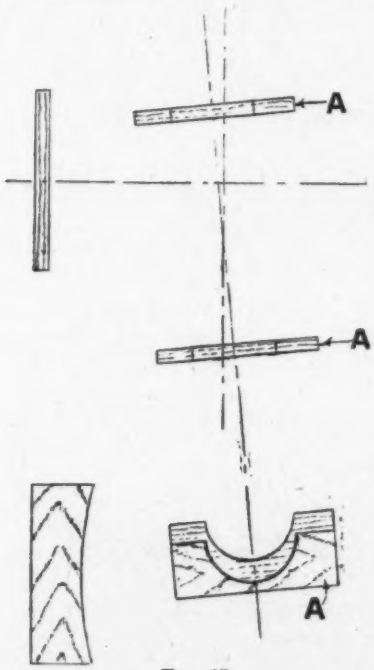


FIG. 17.

bed along its entire length. Sometimes these big fillets are built in four or more sections for convenience in handling both in the pattern-shop and in the foundry, because of the fillet having to be drawn into the barrel space in the mould. This advantage, however, is negatived by the extra trouble in jointing and screwing together after each cast, and the reliability of the fillets also, as

a guide for the arms, no longer exists. It is often, when the barrel is a long one, that the fillet extends from end to end, and it might be wise in such a case to leave the fillet, so that the top above the dowel can be drawn into the barrel separately from the bottom. When a fillet is made, the barrel ought to be turned round and the other fillet built in a similar way. New saddle-pieces will have to be made and probably a new table, as the angles will be different. The careful work-

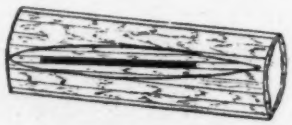


FIG. 19.

man will put on all the necessary centre-lines for both fillets, and make the tables and saddle-pieces before he begins the construction of the fillets. A slight error in these fillets will be a big error in the length of the arms. Two views of the barrel with a finished fillet are shown in Figs. 18 and 19.

It would be quite impossible to bolt the arms to the barrel unless provision were made for

FIG. 20.

the nuts inside the barrel. Blocks A, Fig. 20, should be built and screwed inside to form a square face for the nuts. When the bolt holes have been bored, the whole pattern is ready for being assembled. The saddle-pieces which were used for making the fillets will be used again. The barrel ought to be set as it was when making a fillet, thus ensuring that in the length the arm will be

level. Saddle-pieces should be made for the arm to rest in, their arrangement on the floor being shown in Fig. 17. The hook-bolts—two for an arm—ought to be fixed as in Fig. 21, and when the arm is pushed into its position the nuts can be screwed on the inside of the barrel. In addition to the bolts it is as well to put in some temporary screws on the outside. The arm may be removed, and the barrel set to receive the other arm. It is advisable to bolt both arms in their positions resting on the floor. When the second arm has been fixed it is not necessary to remove it. The other arm will have to be hoisted into position, with the aid of a block and tackle or a crane, but as it has already been in position it is not difficult to replace. The completed pattern is shown in Fig. 22. It is probable that the top arm will

FIG. 21.—BOLT SHOWN IN POSITION.

droop a little unsupported, and stays will have to be fitted between the arms. It would be decidedly awkward to make and fit a half-lapped frame between the arms. The stays which are shown in the sketch should be dowelled and also screwed to blocks fixed on the arms. Before the holes are bored, however, the arms should be tested for position, the distance between the tips

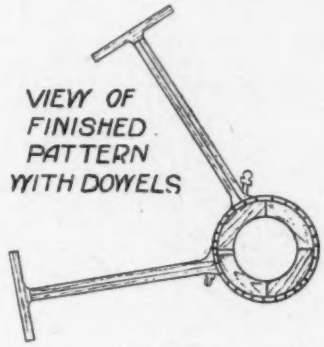


FIG. 23.

of the arms on the centres being obtained from the floor, and the work tested with a steel tape. The best test, however, and the only one probably which will satisfy an inspector, is to drop a plumb-line from the centre of the top palm to the floor, or the top of the other arm, as the case may be, the centre having previously been marked.

If the work is very large it is much better to dissemble it and convey it to the foundry in parts, where it can be easily and quickly put together. The screws, which will have to be taken out by the moulder to get the fillet and the arms withdrawn from the mould, have to be painted round, so that none will be unnoticed and left in. Moulders do not always remember to try if they can get every piece free before bedding a pattern in the sand, although they should do so, and, as with other steel castings, if square corners are wanted anywhere because of the plating, the fact should be written distinctly on the pattern.

For small brackets of this type, or even of the type described in the last article, the arms may be constructed and fixed to the boss in another way. The usual practice, and probably the best, is to make a solid arm of two or three thicknesses of timber and screw extra thicknesses at the ends for fillets. When this is done the whole can be shaped at one operation, and fitted to the barrel. Screws will hold it quite rigid, but it will be

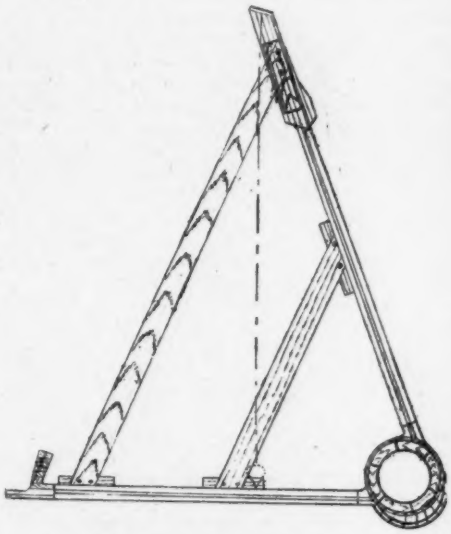


FIG. 22.—VIEW OF FINISHED PATTERN.

a great convenience for the moulder if the dowel-pins are put through the fillet into the barrel. These dowels should be 1½ in. or 2 in. in diameter, and with a good handle, so that they can be easily withdrawn. A suitable form of dowel is shown in Fig. 24, and such a pattern shown finished

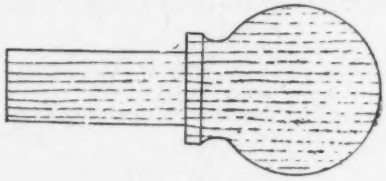


FIG. 24.

in Fig. 23. It is often possible with these smaller brackets to simply screw the palms to the ends of the arms, either leaving the moulder to arrange for the fillet, or making the fillet separately against the arm and palm, so that it can be drawn in. If the foundry is near and the pattern-maker can be in attendance, or can be consulted by the moulder, some details can be left, although it is wiser, within practical limits, to leave, as with other work, as little to the foundry as possible. After all, the pattern-maker is working to a drawing, and it is not quite fair to the moulder for one to expect him to know what is wanted when he has not the opportunity of viewing the drawing.

There should be no difficulty with the shaft core for the bracket, a plain board being all that is necessary.

Foundry Equipment.

By Ben Shaw.

Foundries have in the past been slow to move along lines of increased efficiency, in many, little or no advancement has been shown for years. Now, however, the increased demand for castings, many of a very intricate character, have necessitated a considerable increase in mechanical devices for coping with the increased demands. Though the progress made prior to the war was slow and lacking in enterprise, the advantages of new labour-saving devices have been so great during the past few years that the increased turnover has been a sufficient inducement to further installations. Moulding machines of various types, depending upon the class of work for which they are required, have become quite a common, though necessary, part of the equipment. Many of these machines are of intricate design, and require very skilful handling at the commencement. Much care and forethought in devising the apparatus, and ideal conditions, were necessary to obtain the results claimed for them by their manufacturers, hence it should be a necessary part of the manufacturers' business to ensure that, when their machines are installed in foundries, every endeavour is made to secure working conditions similar to those under which the most satisfactory results are obtained. It is an injustice to the foundryman, and often to the machine, for the manufacturer, who, receiving an order, simply dumps his speciality into the foundry where it is required, without troubling about sending a qualified representative to supervise the fitting up of the machine and instruct in its most profitable use. This very elementary detail in assisting foundries to become more efficient is too often neglected.

In brassfoundries the ordinary crucible furnaces are gradually being displaced by other furnaces of a more up-to-date type, which are capable of dealing with a much larger quantity of metal in considerably less time, taking up less space and requiring comparatively less labour to prepare the metal. The majority of these furnaces are really economical in use, whether they are fired by gas, coke, or oil; and some very remarkable results have been obtained from them; but, as in the case of intricate moulding machines, it is essential that every effort should be made to secure for one of these furnaces the conditions which experience has proved to be the best when installing it in any foundry. Too often an order is received, either through a traveller, an agent, or maybe at the office of the manufacturer, and in due course the furnace, together with the accessories are forwarded to be put up and operated by the foundry management. A considerable amount of very necessary research work has been involved in designing any of these special furnaces, and they are continually being improved. They are capable, under certain conditions, of doing exceptionally good melting, but, unless these conditions are adhered to, as nearly as circumstances will permit, the results may be disappointing. An instance of this kind will serve to show that while some foundries are fully alive to the increased needs of the times, the manufacturers are not yet possessed of that enterprise which would eventually increase the value of their melting devices. In a large foundry an oil furnace had been installed for melting brass. It was a crucible tilting furnace, having a pre-heater, and was supplied by a well-known maker. As installed, it was not by any means efficient nor economical, for three men were required to operate it, and ordinary common brass took an hour and a quarter to melt; moreover, the oil tank was almost directly over the furnace, and so near that on one occasion it took fire, which was only put out after considerable trouble. Had the supply of oil been low, the possibility is that an explosion would have occurred, because all these containers carry a certain amount of vapourised oil when in use. Although this furnace was capable of melting between 300 and 400 lbs. of metal, the amount actually obtained at each heat was very considerably less. No use was made of the pre-heater; in fact, no one seemed to inquire why it should be termed a pre-heater. In the first place, the crucible was filled with scrap. As it gradually sank during the time of melting, the pre-heater was moved to allow more scrap to be thrown into the crucible; consequently, besides chilling the metal already in a molten state, much of the scrap dropped inside the furnace and not into the crucible. Many foremen are not yet familiar with the operation of these furnaces, while others regard such innovations with silent contempt. As far as could be judged, the former seemed most likely to be the cause in the instance referred to, because no one with experience of these furnaces would allow it to continue in operation with a flame of 5 or 6 feet coming through the top cover without either adjusting the air or fuel supply.

The type of furnace referred to should be worked to its utmost capacity, and the time in which the metal should be in a molten state need not exceed half an hour after the first heat has been poured. A muffle-ring should be requisitioned, equal in size to the top of the crucible, the depth varying with the capacity of the furnace. This ring merely extends the crucible, and is only used temporarily, so that a larger amount of scrap can be taken; in fact, the amount which is required to fill the crucible. When in use the metal contained in it is heated before it enters the crucible. When all the metal is in a molten state, this muffle ring is removed, the furnace can then be tilted for pouring. After a little instruction, one man would manage such a furnace with ease, and in a very short time it would become a valuable asset to the foundry. It is also very necessary that the operator should be familiar with the right mixture of air and vapourised oil to give the combustion producing the greatest heat with the longest possible life to the crucible. Too much air will act as a reducer upon the crucible, it being principally composed of graphitic carbon, hence its profitable life would be short. This article is written to suggest to manufacturers of those valuable foundry devices the need for advice and instruction, especially when the mechanism is complex, not only while the apparatus is being installed, but as long as may be considered necessary afterwards, to ensure the utmost production with due regard to the cost. Only by so doing can we hope to increase the value of our foundries and help them to prepare for future possibilities.

Cost of Electric Pig-Iron and Steel-making Plant.

The British Columbia Department of Mines publishes in its Bulletin No. 2, 1919, exhaustive investigations recently carried out with a view to erecting plant for electrically smelting iron ores in British Columbia.

We give the following particulars relating to the design for a plant of 20,000 horse-power (15,000 kw.) to produce a daily output of 100 tons of iron and 20 tons of ferro-alloys.

The plant would handle the following quantities:—Iron ore, 200 tons; charcoal, 50 tons; limestone, 20 tons; electrodes, 2 tons; manganese ore, 20 tons; quartz, 10 tons; chrome ore, 10 tons; scrap-steel, 20 tons.

Although the scheme as a whole is based on a daily capacity of 100 tons of iron and 20 tons of ferro-alloys, the electrical and furnace equipment is only about half of this, corresponding to a consumption of 10,000 horse-power or 7,500 kw., and a production of 50 tons of pig-iron and 5 tons of ferro-alloys, provision being made for extension at a later date. The furnace building would be 50 ft. wide, 30 ft. high, and 150 ft. long. It would contain along one long side two 3,000-kw. open furnaces for smelting iron ore and three 300-kw. open furnaces for ferro-alloys. On the other side of this wall would be the transformer building, 30 ft. wide and 30 ft. high. The supplies of ore for the furnaces would be delivered by an elevated track in front of the furnaces and level with the charging-platforms. The furnace gases would be removed by flues below the charging-platforms. The pig-iron could be tapped into large ladles and cast in sand or in a casting-machine or poured direct into a Bessemer converter for steel-making. The ores and other supplies coming by water would be unloaded into storage by a locomotive crane. The charcoal would need a large storage-shed, perhaps 300 ft. long and 90 ft. wide, which would contain a month's supply, stored not more than 10 ft. deep.

The order of operations would be as follows:—

(1) Unloading from the dock directly into storage.

(2) Removing from storage, using the same crane, to crushing and sampling plant.

(3) Removal from crushing plant to the furnace charge-bins.

(4) Delivering from charge-bins over weighing-hoppers to the charge-cars and thence to the side of the furnace

(5) Smelting for pig-iron or ferro-alloy.

(6) Molten pig-iron received in ladle and handled by crane to casting-bed or casting-machine or to steel-making furnace.

(7) The slag would be received in a ladle and removed by a locomotive.

Building and Engineering Equipment.

The following is the estimated cost of buildings and general plant:—

20,000-h.p. plant with 7,000-kw. of electric furnaces and equipment.

Locomotive crane, buckets, and grab-buckets, £3,800.

Dock, say, £2,000.

Electric locomotive, cars, and equipment for handling between the wharf and the crushing plant, £2,000.

Crushing and sampling, say, £3,400.

Charcoal storage for one month's supply, £1,600.

Tracks, etc., for the above-mentioned equipment, £700.

Lifting-magnet for steel scrap, etc., £240.

Storage of manganese ore, £700.

Storehouse for electrodes and other supplies, including a small crane, £1,200.

Six furnace charging-bins, including weighing-hoppers and mechanical feeders, £1,800.

Tracks, charge-cars, and locomotive, with supports for the overhead track, £2,000.

Furnace building, including crane runway, £5,000.

Transformer building, £2,400.

3- to 10-ton ladles, £1,200.

Flues and stacks, £5,000.

20-ton crane, 50-ft. span, £3,600.

Laboratory and equipment, £1,200.

Office, £1,000.

Machine-shop and blacksmith's shop, £2,400.

Wash-house and change-room, £600.

Slag-handling equipment, £1,600.

Electrical Equipment.

Two 3,000-kw. 3-phase furnaces installed, £6,000.

Seven 1,000-kw. single-phase transformers, £9,100.

Two sets low-tension busses for 3,000-kw. furnaces, £2,000.

Two sets high-tension busses, etc., for 3,000-kw. furnaces, £2,400.

Three 300-kw. single-phase furnaces, installed, £2,000.

Four 300-kw. transformers, installed, £2,000.

Three 50-kw. single-phase transformers, £400.

One 25-kw. motor-generator set for regulators, £400.

Three sets low-tension busses for 300-kw. furnaces, £300.

Land, say, £1,200.

Engineering and contingencies, 20 per cent. on £25,800, £5,160.

Total (approximate), £74,400.

For a plant of 9,000-kw. making pig-iron only, the figures given are as follows:—

9,000-kw. Plant for Pig-Iron.

Building and engineering equipment, £43,400

Three 3,000-kw. furnaces, £9,000.

Eleven 1,000-kw. transformers, £14,200.

Three sets low-tension busses, £3,000.

Three sets high-tension busses, etc., £3,600.

Three 100-kw. transformers, £600.

One 25-kw. motor-generator, £400.

Land, £1,200.

Engineering, etc., 20 per cent. on £32,000, £6,400.

Total, £81,800.

The foregoing estimates of the cost of a 9,000-kw. plant for making pig-iron are for use in calculating the cost of smelting pig-iron. Any plant actually constructed would be more complex in nature, as it would include furnaces for ferro-alloys and for steel-making.

Such a plant, as has already been indicated, might suitably contain:—Two 3,000-kw. furnaces making pig-iron and three 300-kw. furnaces making ferro-alloys.

This plant will produce daily about 25 tons of foundry pig-iron and about 30 tons of white pig-iron for steel-making, together with about 3 tons of ferro-alloys. The plant would cost about £74,000. To make the plant complete and self-contained, there should be added electric or other furnaces for making steel, and a steel-foundry and rolling-mill for handling the steel so produced.

The following particulars are given, showing the cost of a steel-foundry and rolling-mill. This plant would handle in all about 50 tons of steel per day :—

Cost of Steel Plant.

Main foundry building, including drying-ovens, core-ovens, pits, moulds, and a 25-ton overhead crane and runway, £12,000.

Lean-to building for furnace-house, £2,540.

Three 6-ton (rated) electric furnaces, £15,000.

Transformers and electrical equipment for three furnaces, £10,800.

One 9-in. rolling-mill, including building, one continuous heating-furnace, and three reheating-furnaces, £25,000.

Total, £65,340.

Only two of the electric furnaces would be in operation at any one time, and they would use between them about 3,000 kw., which would bring the total consumption in the whole plant up to about 10,000 kw. In British Columbia the probable cost of producing iron in a plant of three 3,000-kw. furnaces, making 27,000 tons of iron per annum, is stated in the Bulletin to be about 124s. per ton with electrical energy at £3 per horse-power year.

Correspondence.

To the Editor of THE FOUNDRY TRADE JOURNAL.

We have received the following reply to the query by K. E. W., which appeared in our June issue :—

DEAR SIR,—We noticed your letter in the June number of the FOUNDRY TRADES JOURNAL, and, in reply, would like to give you the following information regarding McLain's System :—

We subscribed in May, 1917, getting the whole course of twelve lessons at once. Our principal object was to get information about "semi-steel." We altered a cupola, and began making this in October, 1917. We obtained large contracts for aerial bombs, which we made till November, 1918. The test was 14 tons tensile and on 330 consecutive test-bars ¾ in. diameter by 5 in. long we had an average tensile test of 18.16 tons. At one time we were making 1,400 bombs per day. Eight bars, 12 in. by 1 in. by 1 in. were given a transverse test, and gave an average breaking strain of 27 cwt. (for 1-in. bar), with a deflection varying from 0.12 in. to 0.14 in. Semi-steel is not difficult to work, and we found the cupola practice so satisfactory that all our cupolas are now remodelled on McLain's lines. We used Scotch iron chiefly, with steel scrap from plates ¾-in. to ¾-in. thick (no turnings or very thin scrap was used), and got good metal. Frequent analyses and photographs were taken, and in each case the physical structure showed the metal in its strongest formation, very close grained, easily machined, and with the graphitic carbon finely broken up. We have been thoroughly satisfied with our investment, and have found Mr. McLain very helpful and willing to give us information on any points or difficulties put to him.

We shall be glad to give fuller information on any particular point you may wish.—We are, etc.,

CAMERON & ROBERTON, LTD.

August 7, 1919.

Cast Iron and Official Specifications.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. Hurst's reply in your August issue, on page 557, is very interesting, but it is one thing to be in agreement in principle, and something totally different to be in agreement in practice. Principles are ideals, and Mr. Hurst may be referred to the last sentence in paragraph 2 of my letter in your July issue, and to the first half of paragraph 3. There is no admittance on my part that the Aircraft specifications *will* give the required results, but there is an admittance that they *may* do so, as well as a distinct statement by me that a material outside of the analysis in the Aircraft specification may also give the required results. Mr. Hurst asks for the complete data to support this last statement, and he is referred to the conference of piston-ring makers, in June, 1918, two of the minutes of which I quote, and complete details of which are, or should be, in Mr. Hurst's possession.

From Mr. Hurst's last statement it would appear that for, say, piston rings or even cylinders of similar dimensions to those required for aircraft work, not, however, for use in these engines, but for other petrol-driven engines, the chemical specifications for *aircraft* requirements should not be used. It is feared, however, that Mr. Hurst is alone in this opinion. Mr. Hurst misses one principal point in my letter, possibly because of a printer's error. It will be noticed that the eighth line in paragraph 4 of my letter appears twice, as it is also the top line of the second column on page 488 of your journal; in the latter place it is correct, and fits the context, but in the first instance it is out of place, and the sentence should read :—"Hence the silicon, phosphorus, and manganese of these particular *irons became standard specifications. The mixture of* two or more other pig-irons would give a chemical composition within the wide limits named, but would not give the same 'texture'; hence the physical results would be different."

In this connection let me put one question to Mr. Hurst. Assuming that a chemical specification for silicon, sulphur, phosphorus, and manganese has been fixed, because amongst a few irons tried one or two particular pig-irons give the best results under certain melting conditions, would he as a member of a technical committee approve an alternative specification because another member of the committee desired—not on technical or scientific, but on purely commercial grounds—that an alternative specification should be allowed?—Yours truly,

E. ADAMSON.

Sheffield, August 20, 1919.

GERMAN IRON AND STEEL PRODUCTION.—The Association of Iron and Steel Producers has issued statistics concerning the production of iron and steel in June, thus completing the first half of the present year, and exclusive of the output in Luxemburg and Lorraine. The figures for pig-iron in the half-year are as follows :—

	1916. Tons.	1917. Tons.	1918. Tons.	1919. Tons.
January ...	1,078,368	1,082,797	933 570	501,208
February ...	1,036,683	943,547	802,733	469,209
March ...	1,114,194	1,104,653	1,039,092	545,939
April ...	1,073,706	1,131,620	1,084,601	435,242
May ...	1,112,574	1,198,171	1,184,794	524,986
June ...	1,081,507	1,124,998	1,182 415	527,035
Total ...	6,497,032	6,585,786	6,227,205	3,003,619

The production of steel in June amounted to 643,780 tons, as compared with 598,377 tons in May, and the total for the six months is 3,430,000 tons. The tonnage of finished products made by the rolling mills in the first half of 1919 is returned at 2,870,000 tons.

Core-Box Construction.—Part II.

By Joseph Horner.

(*Continued from page 572, August issue.*)

Core-box work, which includes curved and cylindrical sections, is more costly to produce than that in which the sections are rectangular. If cylindrical portions are straight, they can be finished with round planes of suitable radii; but if curved in plan, the whole of the shaping is thrown upon the struck, to be cut inwards afterwards with a paring gouge, guided by lines on the joint faces, and checked with a template.

D and C follow, the guiding lines being on the joint faces only; firmer and carver's gouges being used. The templates are of semi-circular shape, or

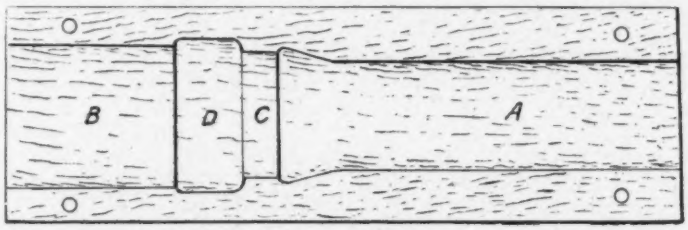


Fig. 1.

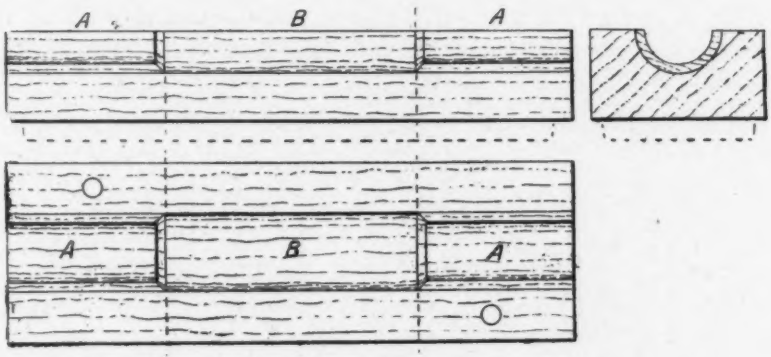


Fig. 2.

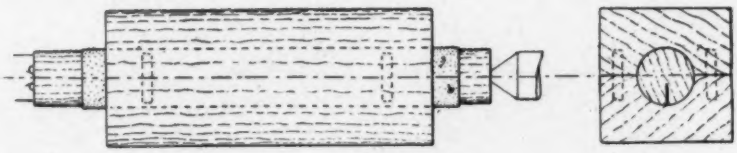


Fig. 3.

gouges. A good deal of this is now performed in the larger shops by rotary cutters in pattern-makers' machines.

When an absolutely straight cylindrical section is departed from, the sections have to be worked in detail. In a comparatively plain box like Fig. 1, the halves being fitted with dowells and clamped with dogs, the circles for the diameter A are struck on both ends and worked right through with planes. Before planing, the circle for B, is a set-square is employed, guided by the edges in the joint faces.

For the box in Fig. 2 a similar procedure may be adopted. The portions A, may be planed right through parallel in the first place, and then B cut, using firmer-gouges. Since the bevel of the cutting edge, which is on the outside of the gouge, is the face in contact with the work, it possesses no guidance similar to that possessed by a paring gouge. A straight-edge is therefore used for longi-

tudinal check in conjunction with a template or a set-square for circular truth. Another method is that illustrated. The box is planed parallel through to the large diameter B, and the pieces A are fitted within. These can be turned outside in the lathe, inserted, and worked with paring gouges and planes. This method is accurate, and has an advantage from the point of view of alterations, since with the same recesses A, can be made smaller or larger as desired.

Another way to make such a box, and those of

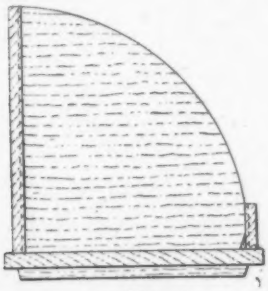


FIG. 4.

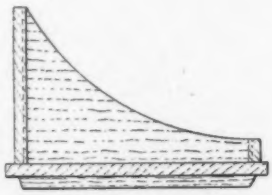


FIG. 5.

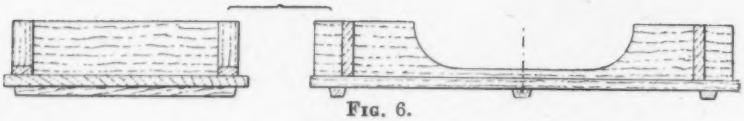


FIG. 6.

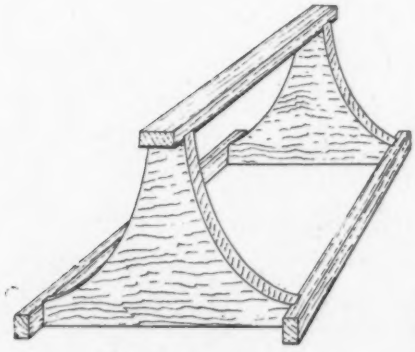


FIG. 7.

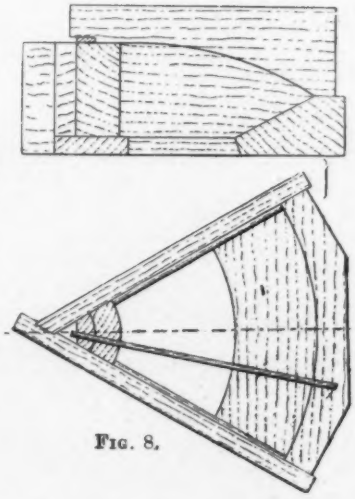


FIG. 8.

which it is typical, is to prepare it in three pieces, jointed as indicated by the dotted lines in Fig. 2, and unite them with a long broad batten screwed on the back of each half-box, shown dotted in the figure. Then B can be planed as readily as A. The batten is screwed on before any portion is worked. The box is marked out, the batten removed, the parts separated, and worked and then united permanently. This general method is applicable to boxes that are much more complicated than this, and which occur in the valve-chambers of pumps and in automobile cylinders. Jointing the sections where differences in dimensions occur, as well as those in shapes, saves a deal of scooping out with outside firmer gouges.

A large group of boxes which are curved in plan is typified by those used for socketed-bend pipes. This is almost wholly work for the outside firmer gouge, and templates must be used working from the lines marked in the joint face. But these are simple by comparison with some where the section frequently changes, and where the shapes in plan may include irregular curves and tapering dimensions. It is then often impossible or unwise to make joints to build up the box at each change of section. Extra care must be taken, as the metal in the casting is thinner. For example, if metal is intended to be only 3-16 in. or ¼ in. thick, error in cutting too deeply would thin it more seriously than if the thickness were ½ in. or ¾ in. In such cases, with castings of complicated shapes which are standardised, it is common practice to take

specimen castings in lead, tin, or white-metal mixture, and saw them through in different directions to check the thicknesses, and alter the core-boxes where required. The permanent core-box is then frequently cast to avoid the risk of a wooden core-box going out of truth. In some cases cores are rammed in the patterns of metal, as in some light pipe-bends.

Whenever possible radii are inserted, or edges bevelled where sections of different diameters meet. But many such parts are facings for brass

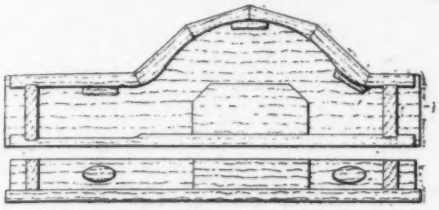


FIG. 9.

seatings and for valves which must be flat. A little taper must nevertheless be imparted to these for delivery of the core similar in amount to that given to patterns for corresponding depths, leaving it to the machinist to face them truly.

Box halves of the shapes now being considered are prevented by means of dowells from being shifted during ramming. There is some risk, if wooden dowells are used, of the box edges losing their coincidence by the wearing and working loose of the dowells in their holes. For this reason those of

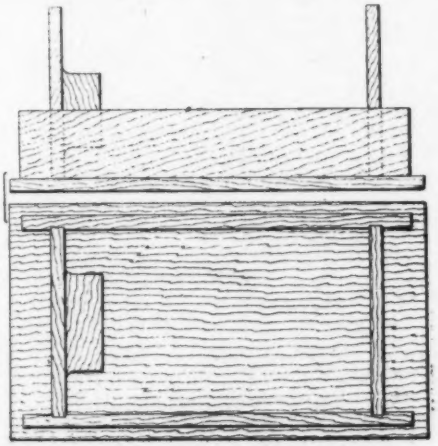


FIG. 11.

brass or malleable cast-iron are to be preferred. Halves are held during ramming with clamps of wood or iron.

To remove the marks of the planes or the gouges from cylindrical boxes a rubber is used, Fig. 3, ran between the lathe centres, with the halves of the box held closed over it with the hands. A strip of glasspaper is inserted in a saw-kerf cut along the rubber and encircles it. The box must be traversed to and fro slightly over the revolving rubber to prevent the formation of grooves.

A considerable amount of work, timber and time are saved in many core-boxes by the application of the method of strickling to the formation of curved outlines, instead of cutting those outlines in timber. In some of these cases the box frame

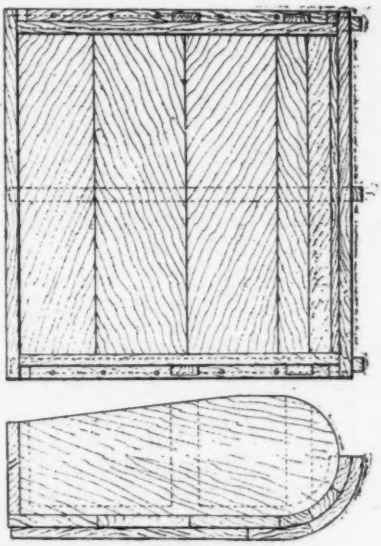


FIG. 10.

is a mere skeleton. Thus, in Figs. 4 and 5, instead of forming the curved portions in blocks of wood, the ends only are cut to the curves required, and a strickle worked along the edges imparts the shapes to the cores. Such boxes can be made in one-fourth the time that would be occupied in shaping the curves in timber, and are just as accurate. The principle has many applications.

In Fig. 6 the deep concavity is formed by strickling in preference to fitting a thick block to the shape. The frame lies on a bottom board. Not because the face of the board is necessary, but in order to afford support to the weak box sides.

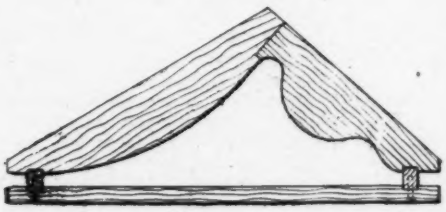


FIG. 12.

Fig. 7 shows a box having two ends curved to guide the strickle. To block up such curves would entail a useless expenditure of timber and time. In Fig. 8 the sides of the box have their top edges cut to the curve of the arms of a bevel wheel made in cores, the teeth being moulded by machine. A strickle worked round and set against a register on the boss-piece imparts the curve to the top face of the core. In Fig 9 the curved portion is shown as formed with blocks, and the box frame is laid

on a bottom board. Here the reason for abandoning the strickle is to have timber to which may be attached the three prints. Alternatively, the curved edge might be strickled, in which case the prints would have to be carried on strips of wood dowelled on the box edges. Fig. 10 shows a box for the main core of a condenser. Here a portion

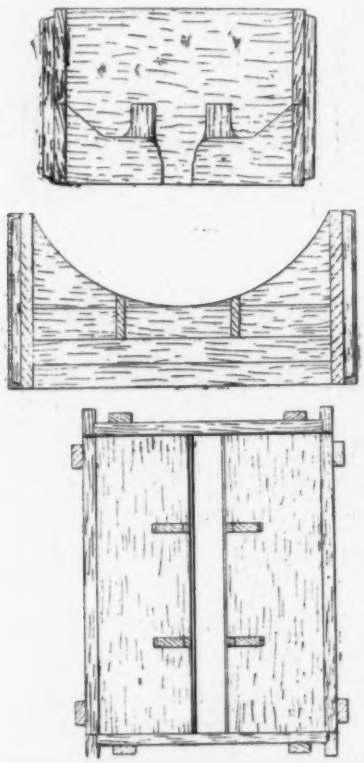


FIG. 13.

of the curved end is made up with blocking to afford support to the sand, but the other moiety is strickled.

Fig. 11 is an illustration of the box for a hooded cylinder. The ends provide the curve for the hood, along which a straight strickle is worked. A bottom board is convenient to keep the frame true. It is often necessary, as when guide-blocks for the cross head are required. Fig. 12 is the core-box for the crank-shaft bearing in one type of engine bed. The box may be made as shown, or alternatively it may have two sides with edges cut to the curves to be strickled. Fig. 13 shows a box for the exhaust port and chamber for a low-pressure cylinder. The curve of the ends on which the strickle is worked gives the metal thickness in the cylinder body. The general construction is indicated by the shaded timber.

THE Ipswich Corporation have decided to purchase British tramway rails, notwithstanding the fact that the British tender was 15½ per cent. higher than the American competitors, and the delivery was over a more extended period.

Welfare Work in Factories and Workshops.

The Home Office has recently issued a pamphlet dealing with the general welfare of workers in industrial establishments, and seeks to provide employers with an outline of welfare-work in factories, to indicate the principles on which it should be based, and to promote a consideration of the subject by employers generally. The Factory Acts lay down certain requirements in regard to the conditions of work, but their requirements do no more than specify a general minimum to be attained in all circumstances. Welfare work has a wider scope. It may be regarded as including everything which bears on the health, safety and general well-being and efficiency of the worker, while avoiding any interference with his private affairs. The chief matters which will require the attention of the welfare management are indicated briefly in the following paragraphs, but the list must not be regarded as exhaustive of all the possibilities of welfare work. It may, perhaps, be said here that, if welfare work is to be successful, it must be undertaken by the management, not merely as a means to efficiency and maximum production, but as being the duty which is owed to all those who are associated as workers or officials in carrying on the nation's work.

General Health.

This includes a number of matters that have long been the subject of statutory regulations which indicate the provisions necessary for the health of the worker. Such matters are, ventilation, heating, cleanliness, and sanitary conveniences. Even here there is ample scope for welfare work. Maintenance of the standards fixed is often difficult or impossible without special and constant care, and proper organisation and supervision.

There are other matters, however, also the subject of statutory regulation, where the standard set is not regarded now as adequate or does not altogether cover the ground, and there are others where there is no standard at present fixed.

Spacing of the Work and Workers.—Under the Factory Act a space of not less than 250 cub. ft. (or 400 cub. ft. during overtime) must be provided for each person employed; but in modern factories it is usual to allow a working space considerably in excess of this standard. Moreover, it is not sufficient merely to consider the total cubic capacity of the room in relation to the total number of persons employed. The work, and the workers, should be so arranged as to take full advantage of the space available. In particular, workers should not be huddled together or placed facing one another at narrow benches; apart from the discomfort caused, the danger of the spread of infection, e.g., by a tuberculous worker is greatly increased.

Lighting.—It is particularly important that attention should always be given both to the distribution of the light, whether natural or artificial, in relation to the work, and to the arrangement of the work so as to use the light available to the best advantage. Lighting must be adequate, and should provide a reasonable degree of constancy and uniformity of illumination over the area of work. Lamps should always be so placed as to guard against glare in the eyes of the operator, and to avoid the casting of extraneous shadows on the work.

Prevention of Fatigue.

This is really a branch of General Health, but as it raises many important questions, some of which affect the whole management of the industry, it is more convenient to deal with it separately. Such questions are the length of the working day, the length of the

spells, the arrangement of intervals and pauses, the hour of commencing work (whether before or after breakfast), the weekly half-day, holidays and so forth. Right arrangements in regard to these matters form the foundation on which welfare work has to be built. These questions are now being widely discussed in the different industries. Hours and spells have too often been fixed in the past merely in conformity with trade customs or local conditions, and without regard to the nature of the operation performed or the fatigue involved. In point of fact it is impossible to select any one system of working as being applicable to all kinds of work, and the best schemes of hours can only be evolved by observation and experiment at the works and by scientific investigation into the question of the causation and prevention of fatigue.

Facilities for Sitting and Rest.—Unnecessary fatigue is often incurred through constant standing. It is better that, if practicable, work should be done sitting rather than standing. Even where the work has to be done standing there are in most cases some intervals when the workers have opportunities for sitting, and so obtaining a short rest; and sufficient and suitable provision (if possible, close to the work) should be made for them to do so. Where work is done sitting, careful consideration should be given to the kind of seat provided, and to its proper adjustment to the work, or to the table, bench, etc., at which the work is done.

Labour-Saving Appliances.—Fatigue is often caused by much unnecessary lifting and carrying of heavy weights. The elimination of all such unnecessary work should be made the subject of careful study by the works management. It can often be avoided by a judicious arrangement of the machinery or plant; but where heavy weights must be lifted and moved, the introduction of overhead runways, hoists, or other lifting tackle, and the use of suitable carriers ought to be arranged for.

Safety.

The Home Office memorandum on this subject is printed in Appendix to the pamphlet, from which we give some extracts:—

For many years a great amount of attention has been given by the Home Office to the fencing of machinery and the provision of safeguards against accidents in general, and considerable advances have been made in preventing the more serious classes of machinery accidents. Nevertheless, in spite of all the efforts that have been made the yearly roll of industrial accidents is still a long one. In 1914, 969 persons were killed and 147,045 persons were injured by accidents in the factories and workshops of this country. It is perhaps not generally realised that machinery is responsible for only a minority of the accidents which occur in factories and workshops. The Home Office records show that more than two-thirds of such accidents are due to other causes. The annual reports of the Home Office Inspectors regularly show that a great number of accidents are due simply and solely to carelessness, inattention, and want of thought. It has been estimated that the percentage of avoidable accidents in some industries is as high as 60 per cent. There is no doubt that a large reduction in the number of accidents would be brought about if managers, officials and workers in factories were determined that avoidable accidents should be prevented and would co-operate in taking the steps necessary to prevent them. Experiments have already been made in many factories in this country which show that most satisfactory results can be achieved by the joint action of employers and workers.

First Aid and Ambulance.—Some Orders have already been issued by the Home Office on this subject for trades in which the accident-rate is high, but arrangements for prompt attention to injuries are necessary in every factory. There should always be available a sufficient supply of sterilised dressings, kept in the charge of some person with a knowledge of First Aid treatment. In large factories more elaborate arrangements with a well-ntted ambulance-room are desirable.

Further suggestions are made for the well-being of workers; amongst these, drinking-water is mentioned; it being considered desirable to avoid putting the supply in places where the water in the pipes or in the vessel containing the water is liable to become tepid through the heat from the works, or in the open air or other position where the worker will be exposed to cold or wet when he goes for water. The best facilities for drinking are afforded by the upward fountain-jet. By this plan the need for a drinking vessel is avoided, since the worker drinks directly from the jet. Where jets are not provided, the water should, if practicable, be laid on in pipes rather than kept in vessels.

Reference is also made to the provision of mess-rooms and canteens, cloak-room accommodation, and washing conveniences.

Selection of the Workers.

Another important matter calling for the attention of the management is the suitability of the workers for the work to which they are assigned, in respect of health, strength, sight, intelligence, etc. This calls for careful selection of the individual worker for the job in the first instance, and for supervision and observation of the worker after appointment. The amount of time lost by workers, their absences from work through sickness, etc., often throw light on the question of a worker's fitness, and a system under which careful records on these points are kept in respect of all the workers, has been found to be very valuable to the management. By these methods the employment of individuals on work beyond their strength or capacity, or unsuited to the worker on some other ground, can often be prevented, and defects in the conditions of work which are prejudicial to health or efficiency may be discovered. For instance, it may be found that unnecessary fatigue is being caused by the faulty adjustment of the work benches or seats, that strain is being caused by the worker having to list or move excessive weights, and so on.

In connection with the organisation of welfare-work, the pamphlet points to the need of a Welfare-Supervisor, whose qualifications are briefly outlined. In the first place, there are the personal qualities which may be summed up under the word "character" or "personality," and on which success largely depend.

(*a*) The Supervisor must, in the first place, be a person who is able to earn the respect of both employers and workers. In a small factory the superior type of forewoman has often proved herself highly satisfactory; in large works a higher educational standard will generally be required, according as the responsibility placed upon the officer increases. In all cases, however, the person selected should be someone who naturally stands out amongst his or her fellows.

(*b*) The Supervisor, who will constantly be coming into contact with other branches of the management, must have tact and judgment to know how to avoid friction and deal with difficulties that may arise with foremen and under-managers through possible conflict of duties.

(*c*) The Supervisor must take a real interest in the work, be quick to observe defects, and possess initiative and capacity to formulate and carry through plans for improving working conditions.

To these personal qualities must be added knowledge of industrial conditions, and of the conditions under which the workers live. This knowledge can only be gained by actual experience of work in a factory and intercourse with the workers themselves in factories, clubs, and elsewhere.

A New Electric Rotating Brass Furnace.

By Cecil H. Booth.

In a recent issue of the "Iron Age" the author contributes an article giving details of the "Booth" electric furnace, which is claimed to overcome the difficulties encountered in previous designs of rotating furnaces.

In the earlier types a door was provided in the cylindrical surface of the shell and lining, for charging and pouring, but considerable difficulty was experienced in maintaining the lining around this combination spout and door. Further, in pouring, the furnace was troublesome and inconvenient, as a result of the necessity of placing a ladle between the supports beneath the furnace. Consequently, in designing the "Booth" furnace these difficultffiies have been overcome by placing the door in one end of the furnace, as shown, and having a tapering hole in the other end. In this way the cylindrical surface of the lining and shell is unbroken by an opening. This permits the continuous rotation of the furnace, and consequently the absorption of heat by the charge from all parts of the lining prevents overheating and ensures uniform wear

Holding Capacities.

As a general rule, the quantity of non-ferrous metal melted at one time, or at one heat, is less

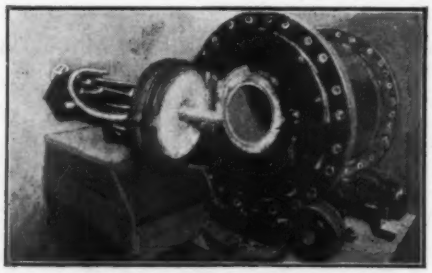


FIG. 1.—250-LB. "BOOTH" ELECTRIC FURNACE WITH DOOR REMOVED.

than the quantities involved in the melting of steel and iron, and therefore smaller sizes of furnaces are desirable. To meet the requirements of the small foundry, as well as the large, and the smelters and refiners, "Booth" furnaces are built in the following sizes :—

Rated holding capacity.	Maximum holding capacity.
250 lb.	350 lb.
500 lb.	750 lb.
1,000 lb.	1,500 lb.
2,000 lb.	2,500 lb.
3,000 lb.	4,000 lb.

There are many small plants where heats of 50 to 350 lbs. are required, and the smallest furnace shown above answers the purpose with great economy, whereas larger furnaces to operate efficiently must produce more metal than is needed. Further, there is a great disadvantage in trying to pour a ton of brass into small castings and keep the metal hot. In addition, the great variety of mixtures made by many small foundries requires a small efficient unit, from which "short" heats can be taken, producing flexibility of operation. On the other hand, smelters and refiners frequently require furnaces of relatively large holding capacity, which will turn out a considerable amount of metal per day. Any one of the above furnaces will melt and bring to pouring temperature a charge of its rated holding capacity in an hour's time when the furnace is hot.

Mechanical Details.

The illustrations give an idea of the general design of the "Booth" electric furnace. The furnace rotates on rollers and is carried by two cylindrical tracks. The rollers are driven at the proper speed by a motor, so as to rotate the shell at the rate of 2 r.p.m. No gearing is required encircling the furnace. The current is carried to the electrodes by means of short pieces of flexible cable, which connect to the track, to which the current is supplied by means of shoes which press against them and form a sliding contact. The electrodes are regulated by means of the screws shown. On small furnaces they are entirely hand-operated, but on the larger furnaces automatic electrode con-

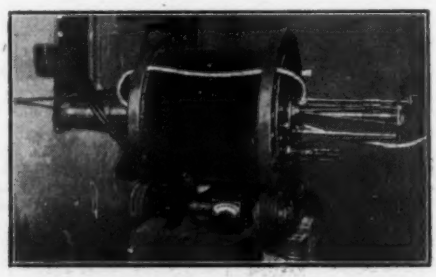


FIG. 2.—GENERAL VIEW OF "BOOTH" ELECTRIC FURNACE, SHOWING ELECTRODE CONTROL-HANDLES, SUPPLY CABLES, AND WATER-COOLING CONNECTIONS.

trol is used, thus doing away with the necessity of close watching on the part of the operator. In the small furnaces the door is in one end only, but in the larger furnaces both ends are provided with a door. Fig. 1 furnishes a rear view of a 250-lb. "Booth" electric brass furnace, in the foundry of Leitelt Brothers, Chicago. This shows the charging door open ready for charging. The latch which holds the door shut when the furnace is charged will be noted and also the electrode projecting through the door. A door of similar type with electrode projecting through it has been in use for a considerable period in the construction of the Booth-Hall steel melting furnace, built by the same company.

In Fig. 2, another view, the flexible cables from the track to the electrode holder are shown, as are also the water cooling connections, for cooling the electrodes. It is not necessary to open the door

until after the heat is poured. The door is then opened for charging. The cylindrical drum-type shell and the track driven by the rollers are visible, and the flexible cable connected with the electrode-holder and the water connections. The pouring tap is shown directly beneath the electrode holder frame. The operator regulates the flow of the current by means of a hand wheel, which can be seen to the right of Fig. 2. Pouring is controlled at a switchboard by means of push-button control.

Furnace Lining.

Probably the most important of all factors in reliable and efficient furnace operation is the lining. Especially is this true with the melting of non-ferrous metals, where a lining with many joints will have a decided tendency to absorb metal.

In order to overcome this difficulty the lining provided with the Booth furnace is made with as few joints as possible. In lining the furnace the electrode supports at either end of the shell are removed by simply unbolting them from the end plates. These are made as a unit, and in taking them off they do not get out of adjustment or out of line, and therefore do not require any readjusting when put back in place. The shell can be lifted off the rollers by a suitable hoist or crane, just as if it were a barrel, and turned on end, so that the endplate of the furnace can be unbolted and removed from the shell.

The door is made of one solid piece of brick with a hole in the centre through which the electrode projects. The cylindrical part of the furnace is made of two cylindrical tiles, which fit together with a tongue and groove joint in the centre, this joint being filled with heat-resisting cement. The ends of the furnace are each lined with four special bricks joined together with cement and cemented to the tile. Thus the furnace is really a large crucible electrically heated, but with walls of considerable thickness, and a minimum number of joints. The lining does not require a brick mason to install it, but can be put in with common labour. The special brick lining is backed up with a layer of heat insulating material, so that when the furnace is working, the temperature on the outside of the shell is so low that one's hand can be placed upon it. Compare this with the large amount of heat in the neigbourood of crucible or other fuel-fired furnaces, and it will become apparent why it is easier to get men to work around a furnace of this character. The time required for relining the furnace is 8 to 12 hours.

Furnace Operation.

In starting the furnace, the tap hole is plugged with moulding sand, the charge placed in the furnace, the door closed and the power switched on. The electrodes are then brought together by means of the moving mechanism shown in Fig. 2, and the amount of current regulated by moving the electrodes closer together or further apart, as indicated by a meter on the switchboard.

If turnings, floor scrapings or grindings are used, the rotation of the furnace is started at once and continues until the metal is ready to pour. No electrode has ever been broken through operating in this manner. If use is made of ingots or heavy scrap the furnace remains stationary until the charge is partly melted, and then rotation is started and continued until the metal is ready to pour. No difficulty has been experienced in regard to breaking electrodes when this method is followed.

As the furnace is sealed up quite tightly from the time the power is on until ready to pour, very good results have been obtained as to metal temperature by keeping the power practically constant for a definite length of time. After the operator has poured a few heats it is possible for him to determine the right temperature practically every time without opening the door and inspecting the metal in the furnace.

In pouring, the pipe stands which carry the water connection simply lift out of the way without it being necessary to unbolt anything, enabling the men to go right up to the furnace with the ladle. When the furnace is ready to tap, the operator stops the rotation when the tap-hole is above the level of the holder and thus above the surface of the metal. The tap-hole is then opened by means of a sharp-pointed steel rod. No sledging or pounding is required, as the tap-hole is simply plugged with moulding sand, which can be very readily picked out with the rod. After the tap hole is opened, the furnace is rotated down until the opening is below the surface of the metal, and the metal poured into the ladle. If it is desired to remove only a portion of the metal the furnace is again rotated back until the tap hole is about the level of the metal. As there are no swinging cables connected with the electrode holders, it has been suggested that the furnace itself could be picked up from its rollers by means of a crane and the metal poured into ingots or castings. This has not been attempetd as yet, but it seems feasible.

Metallic Charges Used.

With the small furnace which is in the plant of the Leitelt Brothers, Chicago, about 130 heats have been poured, using a great variety of mixtures and pouring a considerable number of different grades of metal. The following have been used:—Yellow brass turnings and borings, concentrates from floor sweepings, grindings, foundry scrap, copper wire, sheet copper, red brass ingots, yellow brass ingots, copper ingots, pig tin, lead pipe, pig zinc, and nickel silver.

Power Consumption and Shrinkage.

In melting down turnings, borings and grindings with a hot furnace, 30 to 40 minutes is required per charge. With a small furnace power consumption has been as low as 240 kw.-hr. per ton; the average would be between that and 300 kw-hr. per ton.

With yellow brass turnings and borings which are fairly clean, but on which no attempt has been made to remove any contaminating material, heats have been run with a total shrinkage of 1½ per cent. These borings, when charged, were in the same condition as received from the seller. Of course, the percentage of shrinkage will depend on the amount of oil, dirt, iron and other extraneous material present, but the actual metal loss has proved to be very low. Because of the active mixing action of the rotation, the heat is applied to the turnings and borings in such a uniform manner that there is no local overheating, and a quick melt with low metal loss is obtained.

In melting concentrates from floor sweepings, which contain a considerable amount of dirt and

moisture, and which, when melted in crucibles, showed a shrinkage of 30 to 40 per cent., the furnace, over quite a number of heats averaged 17½ per cent. shrinkage.

In melting ingots and heavier brass scrap, a heat will average from 30 minutes to an hour in length of time, depending upon the kind of metal poured and the size of the charges. A 300-lb. charge of copper ingots requires about an hour to melt and pour, and a 300-lb. charge of yellow brass about 40 minutes. The shrinkage with yellow-brass ingots averages about 1 per cent., and on red brass and high copper-bronze under 1 per cent. With the furnace hot the power consumption will run from 250 to 350 kw.-hr. per ton.

One heat was made with a charge running about 50 per cent. zinc and 40 per cent. copper, totalling 250 lbs.; 249 lbs. of metal were poured, and the power consumption was 240 kw.-hr. per ton. This was in the latter part of the day, when the furnace was hot and the metal charged was all clean metal. The ladle was weighed as it was brought to the furnace, and then weighed after the metal had been poured into the ladle. Great care was taken on the part of the operators not to overheat the metal. The heat following this was a charge of 225 lbs. of red brass ingots, from which 224½ lbs. of metal was poured.

It is particularly difficult to keep account of the metallic shrinkage in a small furnace of 250 lbs. holding-capacity, and consequently great care has been exercised. Arrangements were made for a scale near the furnace, upon which the heated ladle was weighed when brought to the surface, and again weighed when filled with metal. Any drippings from the furnace were carefully collected and weighed, and any slag coming out with the metal was skimmed from the pot before weighing, as even a small amount of 1 lb. would mean almost one-half of 1 per cent. shrinkage. With a larger furnace it would be much easier to make shrinkage tests without danger of as large a proportionate loss as with the smaller furnace.

Lining Wear and Electrode Consumption.

Although to date about 130 heats have been run, the lining on the surface illustrated shows no perceptible wear. It is sintered upon its surface, and appears to be in as good condition as when originally installed. The material of which the lining is made is such that it does not shrink, spall or crack, although the furnace is run on an average eight hours per day. It is believed that linings of this type will last from 600 to 1,000 heats, and possibly longer, with proper care.

An important characteristic of the lining is the fact that it contains practically no joints. This serves to keep it clean and prevents any considerable amount of slag or metal sticking to it.

With furnaces of this type the graphite electrode is to be preferred, because of its greater conductivity, which permits the use of the smallest size of electrode practical for the current to be carried. On this furnace electrodes of 2¼ in. diameter are used—machined and equipped with what is known as nipplejoint. These are 30 inches in length. The electrodes enter the furnace through graphite sleeves, which are protected by a water-cooling copper casting which serves to prevent the electrodes from burning at this point.

Even with the small 250-lb. furnace shown, the electrode consumption is low. If the furnace is kept in operation fairly continuously during an eight-hour day, the consumption will average about 3 lbs. per ton. The electrode supporting mechanism has been so designed that it not only permits of adjustment in case electrodes are slightly out of line, but at the same time serves to protect the electrodes from breakage, through the accidental falling of bars or other material against the end of the furnace.

The Power Factor.

A great deal of difference of opinion still exists among operating engineers as to the proper power-factor to be used in connection with electric furnace loads. With small furnaces of the type described it is believed that as low a power-factor should be adopted as can safely be permitted with the conditions met with at the point of installation. This can be varied to suit different conditions by modifications in the design of the equipment. If a power factor as low as 70 per cent. is permitted, the result will be that the furnace operator need not stay at the electrode hand-wheel control to any great extent, but may be employed in getting his charge ready for his next heat, making suitable records, and other miscellaneous duties. If, however, a higher power factor is required, the furnace can be readily operated, but will require more attention on the part of the operator unless automatic electrode-regulators are provided.

In case a battery of small furnaces is installed and a sufficient advantage in power rate can be obtained by using a higher power factor than 70 per cent., it would probably be best to instal automatic electrode-regulators. There would also be compensation in reduced labour cost, due to the fact that one man could take care of a large number of furnaces under such conditions. On small furnaces of the size described one operator can conveniently handle three furnaces without the use of automatic electrode-control. This would, of course, not include the miscellaneous labour for charging and making up the heats, but one extra man could easily do this.

With this 250-lb. furnace a ton of metal can be easily charged, melted and poured in 7½ to 8 hours. This same rate of speed is maintained for all sizes of the Booth electric brass furnace. With the larger sizes it will, of course, take a little longer time to charge and pour, but proper mechanical means can be provided for charging so as to reduce the time to a minimum. If the furnace is used entirely for melting turnings and borings and other small scrap the daily output will be slightly increased.

Freedom from Explosions Due to Gas Pressure.

Where mixtures are used which might result in the formation of much gas-pressure in the furnace, the charging-door need not be luted up so as to permit of the escape of the gas pressure without blowing out the end of the furnace. This can be accomplished in a very simple manner by leaving the tap-hole open for a short time, in case it is desired to burn off the oil and dirt prior to the melting of the charge. In other words, with a charge of turnings and borings which are dirty and oily, the furnace can be turned around on its rollers so that the tap is located at the top position instead of at the bottom, and then be per-

mitted to remain stationary with the tap-hole open.

Cost of Operation and Upkeep.

The complete rotation of the Booth electric furnace results in more even wear of the lining, a greater absorption of heat by the metal, and consequently improved power consumption. These factors help to bring down the cost of melting and upkeep charges. Since this type of furnace had been in operation only about a month at the time of writing, operating costs are not available.

The rotation of the furnace not only preserves the lining and secures a low power consumption, but at the same time serves to mix the metallic charge, making it more uniform without requiring much supplementary stirring. Except in the case of mixtures with high lead content, the rotation of the furnace will sufficiently mix the charge, so that it is not necessary to stir it either in the furnace or in the ladle.

In the past, the construction of electric furnaces has been along lines which require the use of special electrical appliances and equipment. The "Booth" electric furnace is a departure. It is practical to operate it by ordinary 110-volt single-phase service, which can be obtained from most public service companies.

IRONWORKS ACQUISITION.—Amalgamated Industries, Limited, have purchased the whole of the ordinary shares of Messrs. W. Whitwell & Company, Limited, Thornaby Ironworks, giving them a controlling interest in the undertaking. The purchasing firm recently also acquired the whole of the ordinary and preference shares in the Clyde Shipbuilding & Engineering Company, Limited, Port Glasgow, and all the ordinary shares in the North End Spinning Company, Limited, Lancashire. It is announced that there will be no change in the management of the Thornaby Ironworks, which will remain as heretofore in the hands of Ald. W. F. Whitwell, J.P., Mayor of Thornaby and High Sheriff of Yorkshire, and his brother, Mr. J. F. Whitwell, J.P.

SPONTANEOUS COMBUSTION OF CHARCOAL.—In a recent paper on the subject of "Spontaneous Combustion of Charcoal," before the Royal Society of Arts, Watson Smith, F.C.S., F.I.C., formerly Lecturer in Chemical Technology, Victoria University, Manchester, and, later, Professor of Applied Chemistry in University College, London, referred to the fact that Aubert found that finely-ground charcoal placed in a barrel attained a temperature of 75 deg. C. after fifteen hours; after twenty hours ignition took place. The charcoal was found to have absorbed oxygen and a certain quantity of water. Having once had the management of a wood-distillery, I can testify to the need of great precautions to avoid the danger of outbreaks of fire in the charcoal sheds. Water is always used to quench the hot charcoal after raking it out from the ovens and shovelling it into the underground vaults, just before letting down the lids upon these vaults; and I can easily conceive that the addition of a certain excess of water might cause eventually a tendency to rise of temperature in the charcoal, albeit perfectly cold when raised from the vaults and wheeled to the sheds where it is stocked. In the two or three years I had charge here, there were two outbreaks of fire, promptly quenched, the stocks not being large in each shed. From all I could gather it appeared almost like caprice that the charcoal in most cases kept cold, and yet on the single occasions referred to would heat up even to redness. Doubtless a slight counterbalance of moisture was the apparently capricious cause.

Local Sands for Foundry Use.

The cost of sand is rather an important matter in a good many foundries, and often sands of well-known quality are imported at high prices when equally good material is locally obtainable if a little care is taken in examination and inspection of the sand or loam pits in the district. It must be borne in mind that the mere colour of the sand is no index as to its suitability for moulding purposes, and that in the ordinary acceptance of the word, outside the foundry, moulding sand is not sand, but sandy loam, or loamy sand, and sharp building and other like sands, which are wholly or nearly free from adhesiveness, are not useful for moulding purposes, except to reduce the adhesiveness of too close sands and increase their power of resisting the heat of the molten metal.

Good sand for moulding consists of silica or siliceous sand in various grades of fineness, plus a sufficient amount of aluminous matter to secure adhesion during the operations of moulding and casting. Good sand does not unduly burn into the metal, nor does it wash away during pouring. Micaceous sands are not good, as they both burn and wash, while sands containing chalk or lime are apt to swell and "blow" as the heated metal causes chemical changes in the lime particles.

Beyond sands which are already fit for the foundry after sifting, it not infrequently occurs that various veins of sands are present in a district, not one of which by itself is suitable for the foundry, but with careful blending they may be made of much use for both general and special work. Where such occur, careful trial should be made to secure the right proportions, and then these should be thrown together in a stratified heap, chopped down, and passed through a moderately coarse sieve, and then put in a heap for some weeks, after which they may be passed through a ¼-in. mesh sieve to ensure proper amalgamation, or, what is better, be passed through a sand mill. Usually, where foundry sands have to be imported from a distance, this mixing of local sands will effect a saving of several shillings per ton, and, needless to say, this is an important item where much casting is done.

Naturally, when preparing sands for metal casting it is necessary to know what is required, and then with apparently unfavourable materials it is possible to obtain quite decent results. For instance, clean sea sand is not suitable for moulding, but laid up with clay and weathered for some months, and then worked up and sifted, it is possible to produce a useful article and to turn out decent moulds with it, but, of course, it is not a good moulding sand. In foreign parts it is possible not to have moulding sands, as the writer has found from corresponding with persons in countries where foundry work is not carried on; but by exercising a little discretion very fair makeshifts can be produced, instead of having to wait months for replacement of broken parts of machinery, provided fuel is available and a suitable furnace can be improvised.

Properties and Preparation of Glues.

Glue is a subject which has become of particularly great importance since the development of the use of veneer construction in aeronautics, and the following data, abstructed by special permission of the American Bureau of Aircraft Production, War Department, from a confidential bulletin, and based on experimental work done in the laboratories of the Bureau at McCook Field, Dayton, Ohio, are of more than ordinary interest. Glue is defined as an impure form of gelatine possessing the property of adhesion, which differs somewhat from the popular understanding of the word, which is taken to include all substances having adhesive qualities, with the exception of certain types of cements, shellacs, etc. Glue, however, is really a compound consisting of a large proportion of gelatine with certain other substances, such as chondrin, keratin, and mucin, associated with it, and, in general, the glue advances in the scale of purity as the ratio of gelatine to the other substances present increases.

FIG. 1.—JOINT USED BY THE BRITISH ROYAL AIRCRAFT FACTORY FOR TESTING GLUES.

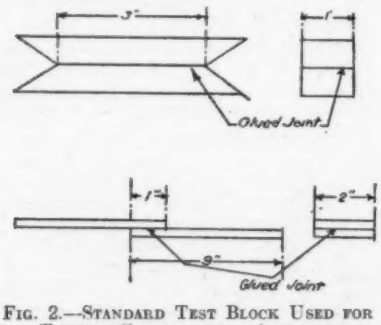


FIG. 2.—STANDARD TEST BLOCK USED FOR TESTING GLUES BY THE AERONAUTICAL INSPECTION DIRECTORATE, U.S. ARMY.

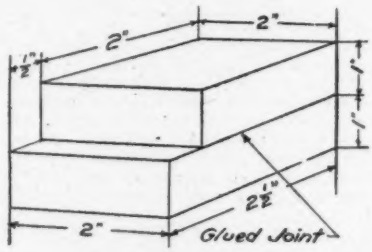


FIG 3.—TEST SPECIMEN DESCRIBED IN BUREAU OF AIRCRAFT PRODCTION GLUE SPECIFICATIONS.

Classification and Most Desirable Properties.

Glues are classified in accordance with the substances from which they are made, as follows:—

1. *Bone glues*, from the horns, raw bones of heads, ribs, shoulder blades, etc., of domestic animals.
2. *Hide glues*, from tannery waste, such as skin trimmings, etc.
3. *Sinew glues*, from the sinews of cattle.
4. *Fish glues*, from fish offals, air bladders, and membranes.
5. *Casein glues*, from fermented milk and other milk products.
6. *Egg-albumen glues.*
7. *Blood-albumen glues.*
8. *Vegetable glues*, from certain non-nitrogenous vegetable growths, such as Irish or Iceland moss, agar-agar, seaweeds, gums, and dextrines.

The above classification includes all the most important groups. Other divisions are possible, such as hot and cold glues, liquid and solid products, etc., but these will be considered later.

The most desirable properties of a glue are:—

1. *Strong adhesiveness.*
2. *Tenacity*, which is slightly different from adhesiveness, and which may be defined as the power to resist the disruptive effect of a stress in any direction.
3. *Elasticity*, or the power to stretch slightly without fracture. In this connection the moisture-content is a very important factor, and glues which are too dry are often inclined to be brittle. While such glues may stand an enormous stress under a steady load, the sudden application of a comparatively light load is liable to cause failure. The constant vibrations, varying stresses and shocks to which airplane members are subjected, make it vitally important to select for airplane construction a glue with a fair amount of elasticity as well as high strength.
4. *Covering power.* This can be determined by estimating the water absorption, the tenacity of the jelly, and the viscosity of a solution of known strength.
5. *Practical working qualities.* Among the most important properties of glue are its workability in the shop, rapidity of setting, etc.

Casein and Blood-Albumen Glues.

The original paper describes the process of manufacture of the various types of glue and the manufacturing elements which determine the properties of the final products. From this point of view the most interesting parts are those referring to casein glues and blood-albumen glues, on which very little printed information is available. The following data are presented in the Bulletin:—

When the sugar of milk ferments, producing lactic acid, the milk turns sour, and casein, the characteristic proteid of milk, is separated in a coagulated mass, due to bacterial action. Casein also may be produced by adding acetic acid to fresh milk which has been diluted and warmed. An appreciable excess of acid must be employed, however, as exact neutralisation of the diluted milk with acid does not precipitate the casein, owing to the interference of the alkaline phosphates present in the milk. In the manufacture of casein glue, the commercial casein is purified by alternate solution in alkali and precipitation with acid, the precipitate being thoroughly washed each time. The number of these treatments determines the purity of the product, and hence its price. Certified casein glue is supplied by the manufacturer in the form of dry powder, the chief constituent of which is the casein derived from milk as just described. There is not very much information available at present concerning the manufacture of blood-albumen glue. It is made from blood, or from serum albumen resulting from the evaporation of the separated serum of fresh blood. The evaporation is conducted at about 50 deg. cent., and the albumen is obtained in the form of flakes varying in colour from greyish to black. Three or four qualites of blood albumen are known, the purest being

a dirty yellow, and the poorest, black. Similar to the casein glues, the blood-albumen variety is waterproof. The article gives some data as to the preparation for use and method of application, especially in regard to casein glues. From this it appears that the principal difficulty encountered with the casein glues lies in the rapidity of setting after mixing with water, as it seems they set at periods from 30 min. to 5 hr., depending on the brand.

Strength of Glue Joints.

Factors affecting the strength of a glued joint are enumerated in the following order:—

In the first place is mentioned the skill of the operator; next, and being almost of equal importance, is the quality of glue which penetrates into the pores of the wood; and, finally, the avoidance of the formation of air bubbles which frequently cause the failure of a joint. With blood-albumen glues the question of mixing and application, especially as regards temperature, is very important, as the glue does not spread properly if too cold. In another part of the investigation, referring, however, more specifically to casein glues, the following enumeration of factors affecting the strength of the joint is given:—(1) Kind and quality of the wood to be used. (2) Nature of the joint. (3) Quality and condition of the glue. (4) Temperature of the glue, of the surfaces of the joint, and of the surroundings. (5) Hygroscopic condition of the wood. (6) Method of application of the glue. (7) Amount and duration of pressure to be employed. (8) Time and conditions of setting, and subsequent drying of the glued joint. (9) Nature of the strain to which the glue is to be subjected.

A highly interesting section of the paper refers to the subject of testing of glues. This is a matter of considerable difficulty, as there are no specific standards for such tests, and the whole subject is on a very indefinite and unsatisfactory footing. In fact, it appears that under one class of test a good glue may show up excellently, while under some other testing method the same material may not indicate nearly as good results.

Testing of Glues.

The tests may be divided into two main classes; chemical and physical. The former are of particular value only in special cases. The physical tests appear to be of more immediate value.

The first examination is sometimes instructive. Thus, the odour of the glue affords some indication of its quality, as a glue having an offensive smell is not considered of the highest grade. The preservative quality of a glue is determined by allowing the jelly left from the jelly strength test, during manufacture, to stand in the laboratory at room temperature for a number of days. The odour and condition of this stock are noted at intervals. Glues with good keeping qualities will stand several days without developing an offensive odour or showing any appearance of decomposition. The consistency of the jelly test suggested by Lipowitz in 1861 has been extensively adopted for commercial purposes. For this test 5 grams of glue are soaked in water at room temperature and then dissolved in enough water at 70 deg. cent. to make the total volume 50 cu. cm. when cold. The solution is allowed to stand in cylinders ¼ in. internal diameter for 12 hr. at 18 deg. cent., and the consistency value of the jelly is then determined by inserting in the jelly a small pointed plunger with a funnel at its upper end, which is gradually loaded with the lead shot until the load is just sufficient to force the plunger entirely through the jelly from its top surface to the bottom of the cylinder. The weight of shot necessary to effect this gives the Lipowitz number.

At the Aeronautical Inspection Directorate Laboratories a round-ended glass rod is employed instead of a pointed steel plunger, and the results obtained have been found to be more consistent and satisfactory. The jelly consistency test is usually accompanied by a viscosity determination of glue solutions. The American Air Service criterion, formerly used, that "the strength of the glue in shear shall not be less than that of the wood," is not sufficient, it is stated. A very poor glue could be made to pass the specification merely by selecting for the test, wood which was considerably below the average of the species in tenacity. The test may be made unfair by using a wood of unsuitable grain. The method officially adopted in Germany is the Spandau test, described as follows:—

It consists in gluing together with a plain butt joint, end-grain to end-grain, two blocks of wood 40 mm. in cross-section and 210 mm. long. Glue stock for the test joint is prepared by dissolving 250 grams of glue in 500 cu. cm. of water, and reducing the solution thus obtained to half of its original volume by evaporation. This is done in order to ascertain whether the prolonged boiling necessary to evaporate the solution will have any tendency to reduce the adhesive properties of the glue. The blocks of wood having been glued together, one is fixed horizontally to a table in such a manner that the joint between the two blocks overhangs a few millimetres beyond the edge of the table. A scale pan is attached to the block a given distance beyond the edge of the table, and weights are placed in the scale pan until fracture of the glue joint takes place. The British Royal Aircraft Factory has a standard glue test which is a modification of the Spandau method. According to R.A.F. specification dated November 21, 1916, a double-wedge-shaped test block is made up by gluing together two pieces of black American walnut, as shown in Fig. 1. The glue solution is prepared according to the instructions issued by the manufacturers of the material. Thus made, the test joint, measuring 3 in. by 1 in., is required to support a static load of 187 lbs. per sq. in. under the following conditions:—

1. *Dry-heat test.* The test piece must support its static load at 122 deg. Fahr. for 30 min.

2. *Humidity test.* It must support its static load in a fully saturated atmosphere for 25 min.

3. *Submerged test.* The test piece, submerged in water, must support its static load of 36 hr.

It is to be noted that the Spandau test subjects the glue to a combined shear and tensile stress, while by the R.A.F. method a direct tension seems to be intended. Strength tests conducted by the laboratories of the Aeronautical Inspection Directorate on glue intended for use in the construction of aircraft are unlike either of those methods previously described, and do not appear to afford a measure of any clearly defined physical constant. The disruption of the glue in these tests is more nearly a shear than anything else; but in any case the results have been found in practice to be reasonably comparable. The procedure adopted in carrying out the A.I.D. strength-tests is as follows:—

1. *Test pieces.* Consist of carefully selected pieces of hard, dry American walnut 2 in. wide by 9 in long and ¾ in. thick. The flat 2 in. sides are planed true and slightly toothed with a fine smoothing plane. (See Fig. 2.)

2. *Constant temperature.* In order to obtain a constant temperature in both the wood and the glue solution under test, a constant-temperature oven, maintained at 35 deg. cent. or 95 deg. Fahr., is employed. The wooden test pieces are allowed to remain in this oven for several hours before the test joint is made.

3. *Preparation of glue solution.* Following the maker's instructions, a weighed quantity of glue is soaked in the required volume of water at room temperature. When thoroughly soaked, which is usually in about 24 hr., the glue is heated in a water-jacketed pot to a temperature of 60 to 80 deg. cent. (140 to 175 deg. Fahr.) for ½ hr. The inner vessel or kettle of the glue pot is then transferred to a constant-temperature oven maintained at 60 deg. cent. (140 deg. Fahr.), and is allowed to stay there for about 1 hr., or long

enough to bring its contents up to the temperature of the oven.

4. *Preparation of test-joints.* Two pieces of the warm wood are then removed from the oven, and the glue is quickly applied to the faces to be joined, using a finger to spread the glue in order to avoid air bubbles. The two pieces are then pressed together so that they form a simple overlap joint 1 in. long and having a total glued area of 2 sq. in. The details of the joints are given in Fig. 2.

5. *Number of test-joints.* Nine joints, made as above described, are prepared for each sample of glue to be tested. They are clamped for 12 hr. in hand presses, such as are ordinarily used in modern gluing practice. The pressure is then removed and the joints allowed to set for 24 hr. at room temperature.

6. *Tests.* Three tests are supplied to these nine specimens, three being subjected to each of the following tests :—

(*a*) *Regular dry test.* Three of the joints are broken in turn by clamping the two ends and pulling the component parts of the joint apart in a testing machine. It is necessary that the load be applied without jerks, and that bending of the test pieces be avoided as far as possible. The load is put on at the rate of about 3,000 lbs. per min., and the amount necessary to break the joint is recorded.

(*b*) *Heat test.* Three of the remaining six joints are then placed in an oven at 45 deg. cent., and are subjected to dry heat at this temperature for 72 hr., after which they are removed from the oven and broken as above.

(*c*) *Immersion test.* The remaining three joints are immersed for 3 hr. in water at 25 deg. cent. (77 deg. Fahr.). On removal from the water they are broken as above.

The three sets of joints are broken on the same day in order that the results may be comparable. Glues are classified in three divisions by the A.I.D., and in order for a glue to be put into one of these classes it must attain the following values in the tests :—

Division.	Breaking point in tests. lb. per sq. in.		
	Regular test.	Heat test.	Immersion test.
Propeller Class...	1,100	1,100	900
Class I... ...	1,100	1,000	800
Class II... ...	900	900	700

It will be noticed that the best glues are thus retained for propeller work. Class I. glues are sanctioned for all important construction exclusive of propellers, while the Class II. material is approved for smaller and less important work. In conducting the above tests it usually is found that the break occurs in the glue, but should the fracture be located wholly or partly in the wood, the result is discarded if the value obtained is below the minimum figure given above. One other point deserves attention, namely, that the figures given in the table relate to the 2-sq.-in. test joint specified. A larger test joint would not show a proportionate increase in strength. For instance, if the area is doubled, the strength will be increased only about 50 per cent.

Relative Merits of different Glues.

The following data on the relative merits of different glues are also of considerable interest. No one best glue has so far been found, since very few records of systematic strength tests are available. Most types of glue suitably selected and manufactured can be made fairly water-resistant. The three kinds of glue suitable for use in airplane construction are the hide, casein, and blood-albumen varieties. Of these, only the casein and blood-albumen types are satisfactory for plywood construction, as hide glue is not truly waterproof. Tests to date show that both these glues can be used to advantage, and it therefore seems advisable to allow plywood manufacturers to apply whichever preparation they prefer. Since the latest Bureau of Aircraft Production specifications for plywood do not bar the use of any glue, it is very important that the soaking and baking tests be carefully made in order to detect the use of any non-waterproof or otherwise unsuitable glue which might show very great strength if not subjected to deteriorating conditions, but which would lack the necessity lasting qualities. Hide-glue has so far been very satisfactory for propeller construction, provided sufficient care be taken to properly guard against moisture and changes in atmospheric conditions. Casein glue may eventually prove more satisfactory for this use, however. Blood-albumen glue is not altogether suitable for general work, except in the manufacture of plywood, on account of the care and expense necessary in its use, the hot-presses and other costly equipment required. Its high strength and waterproof qualities, however, make it excellent for laminated construction. Blood-albumen glue has been found to be even more water-resistant than the casein types. For general airplane use, including splices in spars and longerons, plywood and built-up members, casein glue seems to offer the most advantages. It is nearly as strong as the best hide glues, while it is comparatively waterproof, is fairly easy to mix and apply, and is quite dependable if proper care is exercised. The original paper contains a list of manufacturers of glues, with addresses, and a short bibliography on the subject.

"BLUE-SHORTNESS" AND AGEING OF IRON.—In a recent issue of "Stahl und Eisen," a writer attempts a comprehensive explanation of "blue-shortness" and the ageing of iron and steel, based on the following theory :—

By working the material at temperatures below 500 deg. C. a transformation is set up, which may be termed "ageing." This "ageing," which tends to intensify the effect of cold-working, requires months and years to develop at ordinary temperatures, but takes place more quickly with rise in temperature, so that it may even develop in fractions of a second and so cause the phenomena of blue-shortness. From about 100 deg. C. onwards the consequences of ageing are weakened by the effect of reheating or tempering the metal, which effects are more pronounced the higher the temperature. Based on this theory, it is possible to throw light on the following phenomena :—(1) In strength-tests carried out on hot material, a minimum value of the tensile strength is found at 80 deg. C., and a maximum between 200 deg. and 300 deg. C., in the case of tensile tests carried out at ordinary speed. When the test of speed is increased, the curve showing the strength in terms of temperature is displaced in the direction of the higher temperatures. The yield-point gradualy falls with increasing temperature. The resistance of iron to repeated impacts also shows a minimum value between 200 deg. and 300 deg. C., whereas the minimum notch-impact strength as determined by a single blow lies between 400 deg. and 500 deg. C. (2) If iron is worked at temperatures below 500 deg. C., and afterwards tested at room temperature when cold, a maximum and minimum respectively for all the strength properties of the material is found between 200 deg. and 300 deg. C. The tensile strength minimum at 80 deg. C. disappears. (3) The same results as in (2) are attained when the material is worked cold and then heated to a higher temperature. (4) In order to bring about the above-mentioned charges in iron which are characteristic of "blue-shortness," it is not necessary to heat it, but it is sufficient to leave the cold-worked material lying at ordinary temperature for some time, *i.e.*, to allow it to "age." (5) If completely "aged" iron is reheated to different temperatures, the strength properties gradually fall or rise with increase in the reheating temperature, without, however, showing a maximum or minimum value.

After-War Effects of Two Conflicts.

In a recent issue of the *Iron Age*, under the above title, a writer, B. E. V. Luty, presents a collection of statistics of trade currents during and after the Civil War and the Franco-Prussian War, and attempts to draw conclusions as to the possible trend of events now that Peace has been declared. A diagram, in which a number of trade currents are plotted, is provided, from which we have selected those in the accompanying chart, covering the following:—

Production of pig-iron in the United States.

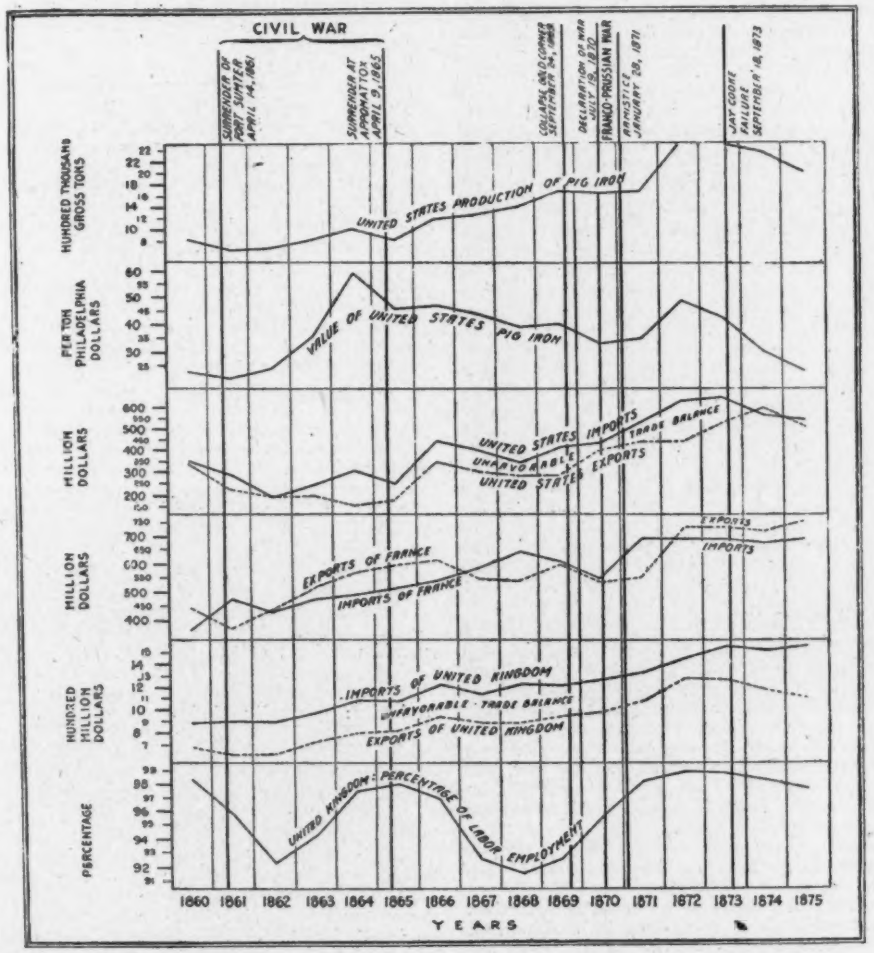
Value per ton of pig-iron, No. 1 anthracite, delivered Philadelphia.

Imports and exports of the United States.

Imports and exports of France.

Imports and exports of the United Kingdom.

Percentage of labour employment in the United Kingdom.


CIVIL WAR
SURRENDER OF FORT SUMTER APRIL 14, 1861
SURRENDER AT APPOMATTOX APRIL 9, 1865
COUPS D'ÉTAT SEPTEMBER 4, 1870
DECLARATION OF WAR JULY 19, 1870
FRANCO-PRUSSIAN WAR
ARMISTICE JANUARY 28, 1871
JAY COOKE FAILURE SEPTEMBER 18, 1873
HUNDRED THOUSAND GROSS TONS
UNITED STATES PRODUCTION OF PIG IRON
PER TON PHILADELPHIA DOLLARS
VALUE OF UNITED STATES PIG IRON
MILLION DOLLARS
UNITED STATES IMPORTS
UNFAVORABLE TRADE BALANCE
UNITED STATES EXPORTS
MILLION DOLLARS
EXPORTS OF FRANCE
IMPORTS OF FRANCE
EXPORTS
IMPORTS
HUNDRED MILLION DOLLARS
IMPORTS OF UNITED KINGDOM
UNFAVORABLE TRADE BALANCE
EXPORTS OF UNITED KINGDOM
PERCENTAGE
UNITED KINGDOM: PERCENTAGE OF LABOR EMPLOYMENT
1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871 1872 1873 1874 1875
YEARS

After referring to the many pitfalls to be avoided in studies of this sort, the writer proceeds to deal with the crisis that occurred in the United States in August, 1857, which, though serious, was considerably less severe than that of 1837. The ensuing industrial depression reached its worst stage in 1859. There was a distinct improvement in 1860, and undoubtedly business would have been good during the next few years if there had been no Civil War. The dates for the beginning and end of the Civil War are plotted from the business rather than from the military or the civil viewpoint. It was the surrender of Fort Sumter, April 14, 1861, not the attack upon it two days earlier, or the secession of South Carolina on the night of the preceding Presidential election, that proved there would be war; for it was on the next day, April 15, that President Lincoln

called for 75,000 volunteers. Likewise the fate of the war was fully known by the fall of Richmond in 1864, but the resumption of the arts of peace only followed the surrender at Appomattox Court House, April 9, 1865, when the Southern soldiers were told to take their horses home with them for the spring ploughing.

The inception of the Civil War caused a great increase in business failures, a great decrease in railroad building, a considerable decline in business activity as represented by clearings of the New York Clearing House, and an apparently small though really serious decline in pig-iron production. The price of pig-iron decreased.

As the war progressed, large volumes of paper currency were issued and gold went to higher and higher premiums. Prices advanced, but it would be unsafe to undertake to determine, by reducing prices to a gold basis, how much of the advance was due to currency inflation. Business failures in 1863 and 1864 were extremely small, this being due, perhaps, to that inflation.

Following the Civil War there was great expansion in business. All authorities agree that the return of the million Northern soldiers to industry failed to cause any disturbance; the men were very readily absorbed. The whole history of industry in the United States for about eight years following the war was one of almost constant expansion and improvement. Yet there were some great uncertainties. There was the famous "Black Friday," Sept. 24, 1869, caused by the failure of the gold corner attempted by Smith, Gould, Martin and Company, the weak link in which was probably the dependence placed upon efforts to keep President Johnson from selling gold out of the Government treasury. The production of pig-iron suffered only a slight relapse in the next two years, while the production in 1872 was 49 per cent. greater than in any preceding year, the price being high at the same time

It is common view of the present generation that, for the United States at least, prosperity and a large "favourable" merchandise balance in foreign trade go hand in hand, and that view is supported.

Detailed comparisons of the trade of foreign countries during and after our Civil War show various slight changes, but they might have been due to many causes other than the war.

In general, there was no great change to be observed. Their trade did not fall off during the war, while afterward it was approximately as much greater than before the war as was the case with the United States. During the war, England suffered severely from lack of American cotton, but that was only one item.

How much of our prosperity was due to the war and how much was merely participation in a world expansion of trade is therefore debatable ground. The one fact that must be accepted is that there was great expansion. A part of it, and perhaps no inconsiderable part, was due to the operations of "carpet baggers," who loaded Southern States with great debts for improvements by which the North endeavoured to prosper.

THE Board of Trade have issued a general licence authorising the payment of fees in respect of the grant and renewal of patents and of the registration and renewal of the registration of trade marks and designs in enemy countries or on behalf of enemies.

The Forming of Graphite in Iron-Carbon Alloys.

At a recent meeting of the American Iron and Steel Institute, Kuniichi Tawara and Genshichi Asahara, of Tokio University, Japan, presented a paper, the object of which was to place before the Institute the results of an investigation by them, carried out with a view to determining how graphite forms in iron-carbon alloys. We give the following abstract:—

As the presence of impurities such as silicon and manganese influences the formation of graphite, the iron on which the experiments were made was prepared from pure magnetic iron-sand found in Western Japan (Tyûgoku), an analysis of the sand revealing the following low percentages of other elements than iron;—Carbon, 0.15; silicon and silicic acid, 0.08; phosphorus, 0.01; sulphur, 0.01 per cent. with a trace of manganese. Copper was entirely absent. Some 27 samples of iron were prepared from this sand by melting in a Morgan crucible with hard charcoal, the attempt being made to keep the charcoal in the final ingots at 3, 3.5, and 4 per cent., and while this did not prove practicable the percentage in no case exceeded 3.93, and in only two out of the 27 samples fell below 3 per cent.

The alloy obtained was a white iron containing practically nothing but iron and carbon, the percentage of silicon in no instance exceeding 0.06 and being in many cases as low as 0.01 per cent. The authors, therefore, justly claim that the formation of graphite must have been determined in all the experiments solely by the physical conditions under which the samples were cast. These conditions were represented by the temperature reached in the melting, which was effected in a gas furnace; the temperature at the moment of running; the temperature of the mould; the time occupied in cooling; and the method of cooling. The temperature of the melt ranged from 1,274 to 1,436 deg. C.; the casting temperature from 1,233 to 1,399 deg. C., while the temperature of the mould was kept at 1,100 deg. C., except in three instances, one of which was a chill at 50 deg. C. The time taken in cooling ranged from ½ hour to 8 hours; generally 1½ hours was given as slow cooling, in one case 3 hours' slow cooling was given, while in others the metal was kept at about 1,000 deg. for 8 hours (7½ once owing to accident) and then quenched in water, while in another the metal, immediately upon being cast, was quenched in water.

The authors conclude that graphitisation can take place even when the total carbon present is as low as 2.18 per cent.; the amount of carbon present when ranging between 2 per cent. and 4 per cent. is not a decisive factor in graphitisation; the variation in the melting temperature within the range of the experiments appears to have no effect; graphitisation does not take place at such a temperature as 900 deg. C., even if maintained for several hours; it may occur at 1,000 deg. C., but the most favourable temperature, as used in the experiments, was 1,100 deg. C.; under the latter temperature there is no appreciable effect on graphitisation, whether the cooling begins directly after the cast or after an annealing-time of three hours has elapsed.

The Coolidge X-Ray Tube.

The application of radiography to the metal industries has taken another step forward in the development of the Coolidge X-ray tube, which has been successfully employed in the X-ray examination of metal castings to find flaws and blow-holes, and for determining the constitution of steel alloys. The method is also valuable in the examination of all kinds of enclosed mechanisms, and of structures in which the absence of flaws and faulty workmanship is of special importance.

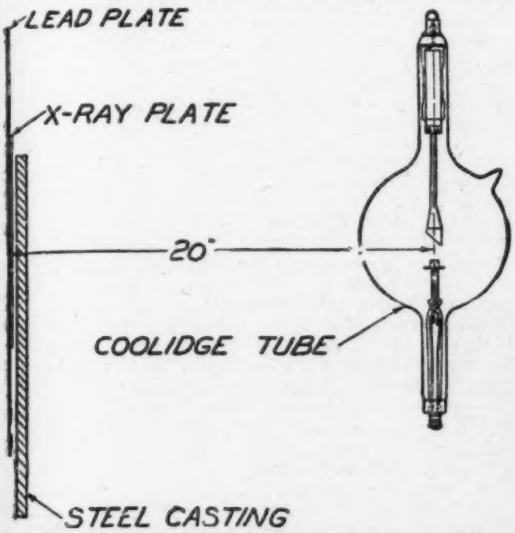


FIG. 1.—DIAGRAM OF ARRANGEMENT OF COOLIDGE TUBE FOR TAKING RADIOGRAPHS OF STEEL CASTING.

FIG. 2.—RADIOGRAPH OF STEEL CASTING, SHOWING IMPERFECTIONS AND CHISEL MARKS.

The Coolidge Universal-type is an improved form of X-ray tube, and differs in construction and operation from the ordinary or gas type of tube. With it X-rays are produced by utilising the principle that a heated body gives off a continuous stream of electrons. The cathode of the tube employs a small spiral tungsten filament (similar to that in an electric lamp) which, when heated by the passage of electricity, projects a stream of electrons against the face of the tungsten target or anode, with a resultant production of X-rays. This operation is a definite and precise one, and the production of the rays can be regulated very accurately, and continued with unvarying characteristics for a considerable period.

Its qualities of precise operation, great penetrative power and convenient regulation render the Coolidge X-ray tube eminently suitable for metallurgical work; a short account of one experiment in the radiographic examination of a steel casting will suffice to indicate its possibilities in this direction. It was desired to examine a steel casting originally 2½ in. thick and weighing about 1 ton which was thought to be faulty. Imperfections had been found during the machining process, and it was necessary to ascertain whether there were other flaws below the surface. The casting was sent into the research laboratory for an X-ray test. A special high-voltage Coolidge tube was set up in front of the suspected portion of the casting, and an 8-in. by 10-in. X-ray plate, backed by a large sheet of lead, was placed immediately behind the casting—the distance between the cathode and the plate being 20 in. The tube was excited by an induction coil with a mercury-turbine interrupter. The current passing through the tube was 1.25 milli-amperes, and the voltage corresponded to a 15-in. spark gap. An

FIG. 3.—RADIOGRAPH OF STEEL CASTING, SHOWING FLAW IN CENTRE.
The circle indicates where a piece was later punched from the casting.

exposure of two minutes was given. The casting was 9/16 of an inch thick at the radiographed point. Several exploratory radiographs (see Figs. 2 and 3) were taken at different points. In all cases the surface tool marks were visible in the radiographs, and in all but one there were peculiar markings which suggested interior flaws. In order to confirm these indications a circular piece 1 in. in diameter (Fig. 3) was punched from the casting. The top and bottom surfaces of this cylindrical piece of steel was quite flawless, but on looking at the edge there was found to be a hole from side to side. Figs. 4 and 5 show the positions of the flaw on opposite

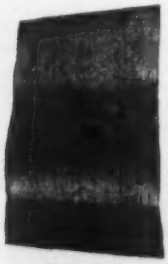


FIG. 4.

FIG. 5.

sides of the punching, as disclosed by the radiographs.

This experiment, and many others which have been made since, prove that the Coolidge X-ray tube will disclose blow-holes or cavities in metal castings of considerable thickness.

IRON AND STEEL PRICES IN GERMANY.—The members of the German Steel Syndicate and of the various price associations met recently at Düsseldorf to consider the question of sale prices, which are resulting in a loss to many of the works. It was decided, however, to refrain from raising quotations for the time being in the hope that peace will now bring about a general fall in prices, and that the reduction in the cost of food products now in progress will result also in a decline in wages.

SONIMS.—An important paper on "Sonims" was read by Mr. Henry D. Hibbard before the recent annual meeting of the American Iron and Steel Institute. "Sonims" is a word invented by the author to denote "solid non-metallic impurities" in steel, such as particles of slag, oxides, sulphides, particles of sand and brick, etc., which are originally included in the steel or become mixed with it mechanically during pouring. It has long been recognised that the chemical analysis of steel, representing as it usually does the metallic and chemical elements in the steel itself, does not completely represent the whole contents of the steel, and does not give a complete indication of the quality of the steel. Non-metallic impurities such as particles of slag and brick or sand from the moulds interfere with the mechanical properties of the steel to at least as great an extent as do the small amounts of phosphorus and sulphur on which the chemists have necessarily laid stress in the past. In view of the great reduction in elongation which is produced by a small notch in a bar, it is obvious that small particles contained in the steel will be certain to reduce elongation, even if they do not greatly reduce the ultimate strength of the steel. In general, the remedy for this state of things is to hold the steel in the ladle for a considerable time after the addition of the deoxidiser, so that the slag and oxides can have time to float to the surface. Even this does not, however, remove the danger of bits of brick and sand from the moulds, and these are particularly apt to be included during the bottom-casting of ingots.

"Keep's Mechanical Analysis."

This system is based on the fact, first demonstrated by Mr. W. J. Keep in 1885, that the shrinkage of a test bar varies inversely as the silicon it contains, or in other words, that the measure of shrinkage is practically equivalent to a chemical analysis for silicon. It is also founded on the fact that the physical properties, apart from shrinkage and softness, are not wholly governed by the chemical composition of the casting. Mechanical analysis measures the physical properties of the iron, which are shrinkage, strength, deflection, set, and depth of chill. The best size of test bar for mechanical analysis is one of ½ in. square section, as this is found to show the greatest variation in strength and shrinkage for the smallest variation in chemical composition. The measure of shrinkage shows at once whether more or less silicon is required to bring the quality of the metal to an accepted standard of excellence. Each foundry fixes upon its best record for any particular class of castings, and the shrinkage of a ½ in. square test bar must come up to the record whenever such class of castings is to be repeated. Should the shrinkage be higher than the standard, more silicon is required in the mixture; if it is lower, less silicon is needed, and more scrap or a cheaper grade of pig may be employed.

As already pointed out, the shrinkage of a test bar varies inversely as the silicon it contains, and as near as can be determined by actual practice every 0.25 per cent. of increase in silicon is equivalent to 0.006 in. per foot decrease in shrinkage of a ½ in. square test bar.

Sulphur has a stronger influence, and increases the shrinkage more than silicon decreases it, but does not have so wide a range; hence, unless the sulphur is abnormally high, the silicon is the controlling element.

In depending upon silicon to decrease shrinkage, attention must, of course, be paid to the other metalloids present; thus, with high phosphorus, which also reduces shrinkage, the result is proportionately larger. Manganese, with high-silicon, helps to reduce shrinkage by neutralising the effect of sulphur, but when high enough to change graphite into combined carbon it acts slower, and in some cases just the reverse. A test bar taken from the first part of a melt usually shows greater shrinkage than one from the latter part of the heat.

Test bars for shrinkage tests are commonly moulded in an ordinary flask, using fine sand, and are poured through a skimming gate, the iron entering the underside of the mould. The bars should be poured with iron near the middle of the heat. The patterns, of brass or hardwood, are placed on an iron folding-board. At the ends of the patterns are iron pieces, which form the ends of the mould and chill the ends of the test bars. Their faces should be moistened with kerosene before and after use, to prevent rusting. After casting, the bars and chill pieces are placed on the follow-board in the same positions as when the patterns were set. A taper or wedge-shaped scale is then passed between the chill piece and the end of the bar, and the width of this space, as measured by the graduations on the scale, shows the shrinkage per foot. To measure the depth of chill, one corner of the test bar is split off.

Loam-Moulding a Small-Diameter Five-Way Flanged Pipe.

By C. Thomas.

In the ordinary course of pipe founding, the top branch of a five-way pipe, such as illustrated in Figs. 1 and 2, would be made by means of a loose core and a core with a small radius placed on the main body-core.

In the particular case discussed in these notes the radius desired at the junction of the top branch is very large, and it is absolutely necessary that the bore of the pipe should be perfectly smooth. Moulding in the ordinary way could not be followed, as this would result in the formation of a bad place where the loose core joined the main body of the pipe.

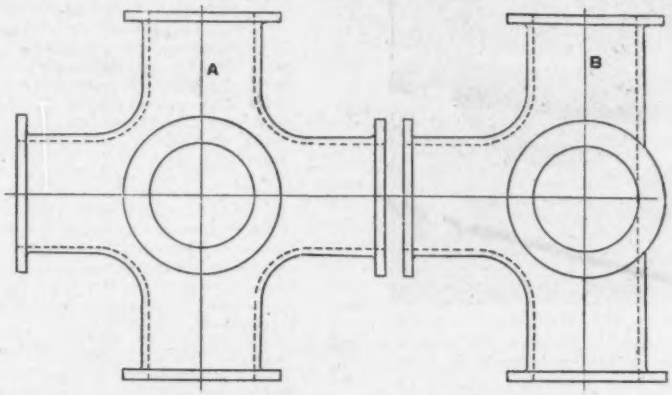


Fig. 1. Fig. 2.

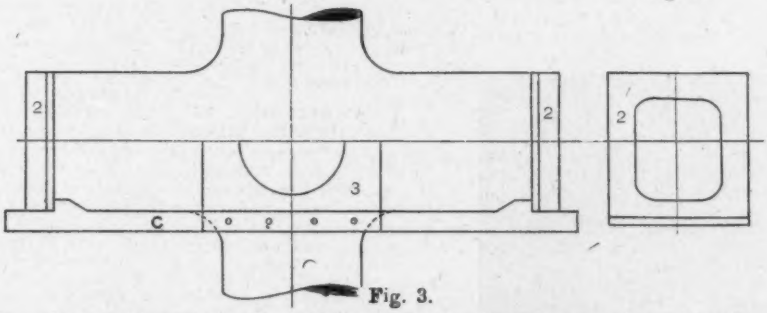


Fig. 3.

Figure 3 illustrates a method of overcoming this difficulty. A plate, as shown in Fig. 3, is first cast of a suitable length and width to allow the pipe pattern to be strickled on in loam. The centre of the branch on the top of the pipe is then marked on the plate. The brackets 2, having been already cast the same width as the plate and 3 in. or 4 in. higher than the face of the flange of the branch, are carefully set equidistant from the centre of the branch marked on the plate, and also exactly at right-angles to the plate. These brackets are held in position by means of cramps. A strickle 3 is screwed to a guide strip C. This guide strip has two notches, by means of which it is centred between the brackets. The skeleton iron to carry the core is made with long, straight prods to carry the top branch. The body core is strickled with the usual strickle as far as the angles, and these are made, using a quarter strickle worked off the plate. The angles or radius of the top branch are left until the whole core is dry, when they are made, using a template on the centre lines of the branches. The remainder is worked in by hand.

The top branch core is formed on the main core by using the strickle with the guide-strip, on either side of the brackets. The core is "thicknessed" in the usual way, with the exception of the branch, and this is left without thickening. When preparing the pattern for the flanges it is advisable to work from the centre branch, so that any slight error in setting the guide brackets may be corrected. The thickness of the branch is obtained by means of a few strips of wood cut the correct thickness and length for the flange to rest on. These are fastened to the branch core by means of a few sprigs and the remainder filled in with sand or loam. The length of the strips is obtained by measurement from the dead-plate on which the pattern is placed to prepare it for the flanges.

Moulding and Pouring Large Cast-Iron Dissolving Tanks.

Industrial chemistry is demanding larger and larger equipment constantly. A recent example is afforded by the following account of the moulding and pouring of large cast-iron dissolving tanks by the Buffalo Foundry and Machine Company, Buffalo, N.Y.

Fig. 1 shows the mould for a 14 ft. 4 in. tank, as it is being prepared, showing the sweep for shaping the

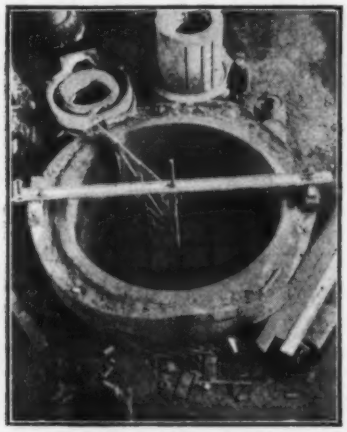


Fig. 1.—Showing the mould for a 14 ft. 4 in. dissolving tank.

cylindrical walls and the pattern-shaped ribs in the bottom. The depth in this casing is about 9 ft. As molten iron has a fluid pressure about seven times as great as water, the need for a deep-pit casting

Fig. 2.—A 35-ton ladle of cast iron being poured into the extra high riser.

is evident. The ground is well vented with cinder bedding and pipes. The walls of the finished mould are torch-baked and finished off similarly to the core surfaces.

After the core has been properly centred and weighted, the mould is ready for the metal. The channel for 4 in. inflow is connected with the base of the mould and in this way a minimum amount of abrasion of the earth walls is assured. Fig 2 shows a 35-ton ladle of cast iron being poured into the extra high riser. This is said to be a special feature with these castings and produces them under great liquid head pressure as well as furnishing large risers in which most of the entrapped sand, gas, etc., is segregated and removed.

Silicon irons are used where resistance to acids is involved in the use of these tanks. Two types of cupolas are used by this company, but there is also an air furnace in which 800,000 cub. ft. of air is used per hour, consuming about seven tons of coke and producing 27 tons of molten iron.

EXPLOSIONS OF ALUMINIUM DUST.—Reports of several disastrous explosions of aluminum dust in manufacturing establishments, says a recent issue of the "Iron Age," induced the Bureau of Mines to investigate the physical and chemical properties of the dust with special regard to inflammability and to the problem of extinguishing fires and of minimising the force of explosions once started. It is reported that aluminium dust burns quietly when in a pile, but if this pile be disturbed in such a manner as to raise a cloud of the dust into the air, the burning takes place with explosive violence. Also, that if a dust cloud already formed having a density within the explosive limits be ignited, a volent explosion results. Moisture is said to be most dangerous if the dust has become heated; hence, as the dust is hygroscopic, a proper system of ventilation is strongly recommended as a precautionary measure. It is equally pointed out that if, when the dust starts to burn from whatever cause, water be added to the mass, hydrogen will be liberated and a terrific explosion result. In one case on record a violent explosion resulted from pouring molten aluminium through a screen into a bucket of water. The tests did not show the exact conditions under which ignition of the aluminium dust is obtained, but it was concluded that it may ignite at temperatures even lower than those necessary for the ignition of 200-mesh standard Pittsburgh coal dust.

VARIATIONS IN THE FRACTURE OF ANNEALED CASTINGS.—Those who have had occasion to order their castings from different firms have no doubt been frequently puzzled by the wide difference in the appearance of the fracture of the annealed castings, varying as it does from a rich velvety black to a silvery grey, the former having a fine fibrous appearance, and the latter being distinctly granular. One form of fracture is especially regarded with suspicion by the inexperienced—viz., that showing a black heart surrounded by silver grey. This is really a good quality of malleable, but the sharp contrast between the heart and the rest of the surface is liable to give one the impression that it is rotten in the centre. The cause of this variation in the appearance of the fracture lies in the different kinds of iron or mixture of iron used by each founder, as well as in the method of annealing, which varies considerably, and if in some instances a well-guarded trade secret. Undoubtedly the finest quality of malleable on the market is that showing the "black-velvet" fracture; and although the cost may be slightly above the average, it is suitable for the highest class of work. So fine is the texture of this quality that it will shear like a piece of boiler plate, and within certain limits it can be forged and swaged either hot or cold. Between this and the bottom of the scale there is a wide range, the lowest showing a coarse, granular fracture, not much unlike soft grey pig; this is only suitable for castings that will not be subject to shock or to alternating stresses.

Defective Motor Castings.

The difficulty of obtaining sound engine castings was referred to in a short paragraph taken from the "Autocar," and published in our last issue, in which the writer stated that bad castings were retarding the productions of engines and parts to a very grave extent.

A correspondent, writing on this subject in a subsequent issue of the "Autocar," gives some suggestions for getting over the difficulties referred to. He says:—"As a practical foundryman, I regard this as a most alarming state of affairs. General statements are always difficult to combat, and perhaps your contributor has better opportunities of knowing and seeing this awful waste of effort than I have, though I certainly know one or two large foundries which are making as intricate castings in iron, semi-steel, aluminium, etc., as anybody in the trade, and who are not getting the enormous scrap returns which your contributor appears to believe are general.

If motor-car casting production in this country is so bad, it is high time that the discussion of results gave place to the discussion of causes. The assertion that "it has yet to be determined how far the difficulties of foundrymen are to be traced to the basic metals," I do not agree with. In these days it should surely not be necessary to discuss this side of the question. Foundry managers or owners who are trying to run their foundries without scientific control, and cast intricate motor castings without knowing exactly what they are putting into their furnaces, and, what is still more important, what they are taking out, deserve any trouble that is coming to them.

There are many ways of making bad castings, and only one way of making good ones. Bad metal spoils a perfect mould as easily as an imperfect mould will spoil the most scientifically mixed, melted, and poured castings. It is my firm conviction that when it comes to clinging to precedent the average foundry man has everybody else trimmed. He is still mixing metal by fracture instead of by analysis, and he still thinks the chemist is his mortal enemy. He makes up charges by guesswork, using a 10 cwt. charge when the furnace would quite easily take a ton, using small fans and running a heat two hours when a big healthy fan would bring it down in an hour: this because somebody told him he would blow all the carbon out of the iron and so make it hard.

Since I first started work in the foundry many changes have been brought about. Improved processes have been adopted, machinery has been introduced, and science and technology have caused time-honoured, rule-of-thumb methods to be discredited and discarded, and if we are a long way from a desirable state of efficiency, if our scrap-heaps are too large, it is because the foundries have not moved with the times. The knowledge and experience are to be had: it is simply that a lot of men who are managing or mismanaging foundries are not foundrymen. When persistent casting losses do occur, the up-to-date, scientific, and practical man can invariably locate the trouble, and very often anticipate it. One of the reasons is that he has entirely eliminated the luck fetish from his mind and looks for causes. If this huge scrap pile referred to causes manufacturers to realise that the foundry is either a bottomless pit or a mine of wealth it will not have been made in vain. What I cannot understand is that manufacturers can allow hundreds of any job to be made in the hope of getting a few good castings. I cannot imagine such a state of things. Scrap castings are caused by something being wrong, and it will be impossible to eliminate scrap until we eliminate the personal element, which will never be done in the foundry. Two and a half per cent., or, at the very highest, 7 per cent. on intricate work should cover this. When scrap is higher than this something more serious is wrong, and it is time somebody got down to business.

Foundries have been given seemingly impossible jobs before now, but I have never yet seen the job it is not possible to cure somehow. It may be one or more of a hundred things that is causing the trouble. Concessions from the designer have often cleared away the troubles of the foundryman. In these days it can be truly said that zeal and enthusiasm amongst the workers are seldom seen. My experience is that it is absolutely necessary to have a very careful and rigid supervision and inspection, not of castings, but of moulds and cores. There are still some workmen about in whom it is possible to awaken some real interest in their work, and with a few of these in a shop the others can be fairly easily made use of. To produce good work under present conditions increases a foundryman's difficulties; but things will change, and we shall settle down to work, and it will then be easier for all of us; but to get absolutely sound work and the utmost quantity of it in the foundries we need practical men with scientific knowledge as managers or superintendents—men capable of exercising a firm but tactful control, practical men as foremen and supervisors. Foundry and pattern shop must be under one control; there must be constant co-operation with the drawing office and foundry manager on all castings of new designs, and active co-operation of the laboratory to determine chemical contents of all material used in the foundry, and chemical contents and physical properties of all products from the foundry. Further, there must be a real effort to create interest, enthusiasm, and confidence in the men, and a better and more general system of training apprentices than is usual in foundries to-day. This latter must be speedily adopted. In fact, it requires everybody to be right down on his job. There is no use for the careless workman in the foundry to-day, any more than there is for th manager who trusts to his luck. Castings are too easily lost."

MANCHESTER COLLEGE OF TECHNOLOGY.—According to the prospectus of University courses in the Municipal College of Technology, Manchester, just to hand, the session 1919-20 will open on October 8, 1919, and end on July 27, 1920. Students who are able to obtain an approved course of practical training extending over not less than two months in a works or otherwise will be excused attendance during the long vacation term. Students will be enrolled on October 6, 7, and 8, between 10 a.m. and 4 p.m. New students can also be received at the College of Technology between 10 a.m. and 1 p.m., from September 29 onwards (except on Saturdays). After October 31 students are only admitted for special reasons by permission of the Principal and the Vice-Chancellor.

Heat-Treatment of Aeroplane Parts.

In a recent issue of the "American Drop Forger," an article appears under the above title, by Fred Grotts, from which we give the following data:—

In case-hardening material, it is kept at 1,600 deg. to 1,650 deg. F. for 6 to 12 hours, according to the penetration desired. It is then cooled in the boxes and removed and cleaned. The heat-treatment consists of heating to 1,600 deg. to 1,625 deg. F., to refine the core, and quenching in oil. Then the material is reheated to 1,425 deg. to 1,450 deg F., and quenched in water.

Forging material has an analysis of about 0.35 per cent. carbon, 0.65 per cent. manganese, 0.04 per cent. sulphur, and 0.04 per cent. phosphorus. The heat treatment consists of heating to 1,550 deg. F., quenching in oil, and drawing at 975 deg. F.

Nickel-steel is used for bolts. The analysis is 3.65 per cent. nickel, 0,30 per cent. carbon, 0.55 per cent. manganese, 0.043 per cent. sulphur, and 0.04 per cent. phosphorus. On account of pipes and slag, much of this material has to be rejected. The claim that pipe can be removed by heat treatment is incorrect. The heat treatment consists of quenching at 1,500 deg. F. in oil and drawing at 1,000 deg. F. Nickel-steel will stand considerable cold-working, and, furthermore, it will not be affected as much as a similar plain carbon-steel by overheating, since its distorted structure becomes readjusted when it is reheated at 1,500 deg. F.

Chrome-steel is noted for resistance to corrosion as well as high-tensile strength. A typical analysis shows 10.44 per cent. chromium, 0.24 per cent. carbon, 0.36 per cent. manganese, 0.30 per cent. vanadium, 0.013 per cent. sulphur, and 0.020 per cent. phosphorus. This alloy is quenched at 1,800 deg. to 1,825 deg. F., and drawn at 850 deg. F.

Two different alloys of chrome-nickel steel are used. One contains 3.5 per cent. nickel, 1.5 per cent. chromium, 0.35 per cent. carbon, 0.55 per cent. manganese, 0.04 per cent. sulphur, and 0.04 per cent. phosphorus. This is quenched in oil at 1,475 deg. F., and drawn at 820 deg. F. The other alloy contains 1.25 per cent. nickel and 0.65 per cent. chromium, the other constituents being practically unchanged. This is quenched in oil at 1,550 deg. F. and drawn at 900 deg. F. Piston-pins, steam-line wire, crankshafts, and connecting-rod bolts are some of the articles made of chrome-nickel steel. Sometimes improved results are obtained when double-quenching is employed. Piston-pins often crack when left in the quenching medium until cold.

Chrome-vanadium steel is used to a considerable extent for piston-pins and connecting-rod bolts. Double quenching gives the best results. Crankshafts and piston-pins should be quenched either horizontally or vertically in order to avoid internal strains. Two alloys are used. The first contains 0.45 per cent. carbon, 0.80 per cent. manganese, 0.04 per cent. sulphur, 0.04 per cent. phosphorus, 0.95 per cent. chromium, and 0.15 per cent. vanadium. This is quenched first at 1,700 deg. and again at 1,600 deg., and then drawn at 1,000 deg. F. In the second alloy the carbon is reduced to 0.35 per cent. and the manganese to 0.65 per cent., the other constituents remaining the same. The two quenchings are at the same temperatures, but the material is drawn at 1,200 deg. F.

Vanadium acts as a cleanser of the molten steel, and even when its presence cannot be detected in the finished product, it removes nitrogen and oxygen. Vanadium also increases the tensile strength of steel. A typical analysis shows 0.22 per cent. carbon, 0.72 per cent. manganese, 0.039 per cent. sulphur, 0.04 per cent. phosphorus, and 0.18 per cent. vanadium. Up to 0.7 per cent. vanadium the strength of the steel increases.

Among the non-ferrous alloys, duralumin is one of the most interesting. It contains 94.92 per cent. aluminium, 3.43 per cent. copper, 0.40 per cent. iron, 0.74 per cent. magnesium, 0.47 per cent. silicon, and a trace of manganese. It is treated by heating to 900 deg. F., and quenching in water.

Effect of Rest on Steel Tests.

In a Paper to be read before the American Institute of Mining and Metallurgical Engineers at Chicago, on September 22-26, G. A. Reinhardt and H. L. Cutler describe in detail a series of tests which have been carried out at the laboratories of the Youngstown Sheet & Tube Company, Youngstown, indicating that specimens of medium-carbon steel show widely varying tensile strengths which are influenced by the temperature of the material when tested and the time elapsing between the moment the metal is tested and the time it is machined. In testing the material the test blooms were either normalised or annealed. The normalising consisted in heating to from 850 to 900 deg. Cent. and cooling in still air; the annealing in heating to from 850 to 900 deg. Cent. and cooling in the furnace or in mica. The test-pieces were taken from the treated bloom either by core-drilling or by sawing from points midway between the edges and the intersection of the diagonals. The cores or blocks were turned to a standard 2-in. test piece with a diameter of 0.564 in.

In the first series of tests four cores were drilled from each of six untreated blooms. Two cores from each bloom, after machining were rested two days at room temperature before testing. The two duplicate cores after machining were rested two days on top of a Hoskins hairpin-type electric furnace where the temperature was about 120 deg. Cent. The chemical analysis of the test-pieces is given as carbon, 0.33; manganese, 0.75; sulphur, 0.034; phosphorus, 0.060. In the case of those which received two days' rest at room temperature the tests showed a yield-point of 60,140 lbs. per sq. in., and an ultimate strength of 106,350 lbs. per sq. in., while the elongation was 10.5 per cent. The two specimens which rested two days on the furnace, at a temperature of 120 deg. Cent., showed on test a yield-point of 55,310 lbs. per sq. in., an ultimate strength of 109,050 lbs. per sq. in., with a 16.25 per cent. elongation.

A second series of tests was made in identically the same manner except that, after machining, a rest of four days was given the test-pieces before testing. The test pieces kept at room temperature gave a yield point of 50,970 lbs. per sq. in., ultimate strength 101,250 lbs. per sq. in., and an elongation of 10 per cent. However, in the case of the specimens which received four days' rest at a temperature of 120 deg. Cent. the results were:—Yield point, 51,590 lbs. per sq. in.; ultimate strength, 103,200 lbs. per sq. in., and 17 per cent. elongation. These two series of tests showed that a slight increase in temperature resulted in a great improvement of elongation and reduction of area. There is a general increase in the tensile strength, which, however, was greater in the case of a two days' rest than in the case of a four days' rest.

Moulding a Large Column in Loam.

By E. Longden.

The following article describes the tackle and method of moulding large columns in loam. Fig. 1 is a sketch of a furnace-column, weighing 7 ton 5 cwt., the casting of which recently came under the writer's supervision. Many foundrymen contend that loam-moulding is the costliest method of producing castings if more than one is required; but the casting under consideration was made much more quickly struck up in loam than by dry-sand moulding from a full pattern. A costly pattern was also saved. It will be obvious from the dimensions of Fig. 1 that for a casting of the size indicated the tackle would be of an unwieldly length and difficult to stove. A casing, or box-part, is required as shown in Fig. 2, which is divided in the centre at A, two pieces forming the bottom half and two the top half of the box. The dividing of the box is also provided with a view to the utility of the tackle for shorter columns, hydraulic cylinders and rams, etc. Fig. 2 shows the bottom half, with the two portions bolted together and the strickle set for moulding. The casing conforms to the shape of the column, with pockets B at each end to receive the flanges. Provision is made on each section of the casing at A, for bolting together, the dimensions being such as to allow 4 in. of brickwork, with 1 in. of setting-loam and 1 in. of loam on the face of the bricks; this allows sufficient room for setting the brackets, which are larger than the general body of the casting. Holes are cored out along the casing to help the drying and act as vents. In making the top part of the casing, additional holes are provided to allow runner and riser gates, and chaplets, and for bolting grids which are fastened to the top to hold in the brickwork when the latter is turned over. Openings are provided at each end, top and bottom, to allow the core and barrel to protrude through the box, as shown at A, Fig. 3. In the top part a bar should be fitted in the pockets B at each end of Fig. 3, to form about 4 in. of space between the end of the box and bar. This space is left open when building the top half of the box to provide an effective way of sealing the ends

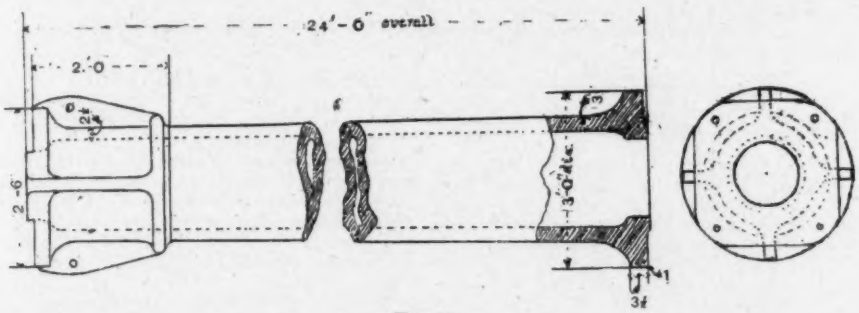


FIG. 1.

of the mould when closing. Holes are provided along the flanges C, Fig. 2, to bolt the top and bottom parts together. The joints of the casing must be machined, as the correctness of the mould depends upon this, as well as the spindle bearers, Fig. 4, which are bolted on each end D, Fig. 2. Also, two or more bearers similar to that shown at E, in Fig. 2, are made, according to the strength of spindle, to support the latter along its length, to ensure a true sweep in the mould.

Collars are put on the spindle, on the outside and inside of the bearers at each end, to prevent end-play. The two boxes forming the bottom casing are placed on the floor, levelled and straightened by stretching tightly a piece of string the full length of the two parts, and bolted together. The patternmaker should overlook and help in setting the strickle on the spindle. The sweep board requires cutting in three or more places to allow of the free movement of the "sweep" past the bearers which take the weight of the spindle towards the middle. After setting the casing ready for moulding, the rectangular flange at the end and the brackets are set, after which straightforward bricking is proceeded with. At a distance of 8 ft. and 11 ft. respectively from each end iron

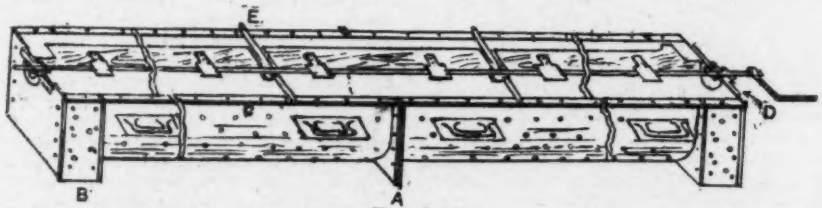


FIG. 2.

bars are set in the brickwork down on to the iron casing to act as bearers for the cast-iron studs, Fig. 6, which are divided into two pieces at about the same place as the box, their purpose being to bear the weight of the core and barrel. With a view to the repeated use of the brickwork, as first set, the bricks are laid soundly in new loam. It is not necessary to fill-in cinders or dry sand between the brickwork, as is done with more open moulds.

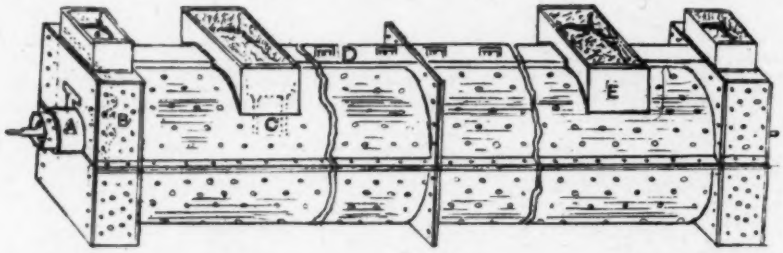


FIG. 3.

The brickwork and loam is not deep, and with the vent-holes along the casing and a good open loam, no risk is taken of a scabbed mould.

In the middle, where the box is divided, the bricks are set to form a vertical joint, loam being rubbed on and a parting sand-face provided. About 1 in. of loam is well rubbed on to the brickwork

FIG. 4.

over the whole length of the mould, and the mould swept to shape. The joints are strickled with a straight-edge board across the machined flanges of the casing. When the roughed-up mould has partially set, fine loam is spread over the surface, using the bevelled edge of the strickle. The mould is then allowed to set. The top half of the casing

FIG. 6.

is levelled and bolted together in the same manner as the bottom. Grids are bolted firmly along the whole length of the joint on either side of the mould, the depth of the grids from the joint face being arranged to take one row of bricks between two rows of stout prods, which are cast on the grids. The remainder of the brickwork is thus

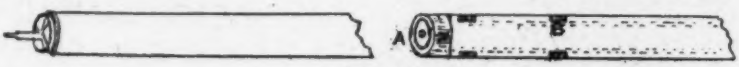


FIG. 7.

held in by the first row of bricks and grids. Before bricking the mould runner-gates C, Fig. 3, are set at each end of the column, about 4 ft. from the flanges, and riser gates on each flange. The top half is then struck up similar to the bottom half of the casing and left to set.

When the complete mould has stiffened, it is unbolted and dressed before being stoved and dried. The core is made in two lengths, about 13 ft. 6 in., on strong cast-iron bars. At the centre, where the cores butt together, A, Fig. 7, the ends of the core-bar must be cast solid or plugged, and tapped to receive the trunnion for turning the core when strickling. When coring, the trunnions can be taken out and tapped, and the holes sealed with sand; the metal is thus prevented from penetrating the barrel of the core through the joint where the cores meet. Iron bearers are set in the core B, Fig. 7, down on to the iron barrel, corresponding with the iron bearers set in the bottom half of the mould, and the chaplets which are inserted through the top part of the mould to hold down the core when filling the mould with metal. If this provision

FIG. 5.

were not made, the studs and chaplets would bury themselves in the core, or in the mould, as loam will not withstand the heavy core and the "lift" given to the core by the pressure of metal when fluid. If 8 per cent. of coal dust is added to the loam when milling, it will help in the extraction of the core-barrels after casting. When the core and mould are dry, the two pieces forming the bottom half of the mould are again set on the floor, the top parts of the mould tried on, and set by the spindle-bearers, Fig. 4, which are still attached to the ends of the box, top and bottom. Guides are then bolted on to previously prepared places along the flanges, the top portions of the box again removed, and the spindle-bearers unbolted and taken off the ends. The cast-iron studs are next placed on the iron bearers in the bottom half of mould and cores set. Chaplets are wedged to the sides of cores and the iron casing to prevent any movement sideways. The mould should be tried with clays to test the thickness; the usual test for ascertaining the thickness of metal in such columns being to drill holes at given points. Strong chaplets are inserted through the top parts and the mould closed down, the joints sealed with black loam, and the four parts bolted together. The ends are sealed by ramming sand in the 4 in. of space formed by the ends of the box and bars as previously described.

Chaplets are securely wedged down under the bars D, Fig. 3. Runner-boxes E are placed in position and made up with facing sand, blacked and dried; the risers are made up with black sand, and the mould is ready for running.

After casting, and when the metal has quite set, the core barrels must be extracted. The barrels are given a start by twisting with the trunnions at the ends, and drawn out by the crane. If care is taken in making the core, and the correct time —about 1¾ hours after casting—chosen for taking out the core-bars, no trouble will be experienced in extracting the barrels.

After the first casting has been made, a moulder and a labourer should make castings in about 6½ days.

The Wedge Optical Pyrometer.

A new system of optical pyrometry has recently been introduced by the Optical Pyrometer Syndicate, Audrey House, Ely Place, London, E.C.1.

The method employed makes use of the principle of the absorption of light in reading temperature, the light emitted by the heated body being absorbed by a special prism, and the temperature read at the extinction-point. Even under the best laboratory conditions, one cannot expect an approximation nearer than 2 deg. C., while at the melting-point of iron, say, 1,520 deg. C., the approximation cannot be expected to be nearer than 15 deg. C. In works practice a still greater latitude must be allowed.

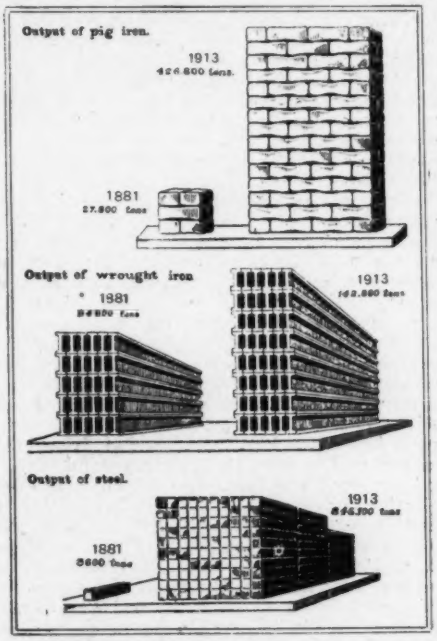
For the highest temperatures the only reliable methods of determination are based on the Theory of Radiation.

In this theory the fundamental conception is that of the "black body," a body which absorbs all the radiant heat and light falling on it, and reflects none at all. Coal and iron approximate to the condition of the theoretical "black body." Bodies not "black" in this sense, if opaque to light and heat, reflect a certain proportion of the radiant energy which falls on them and absorb the rest. In the "Wedge" optical pyrometer the light emitted by a heated body passes through a wedge of red glass, which allows only red rays to penetrate it, and the intensity of the radiation of light of this wave-length is determined by the thickness of glass through which it can pass. The colour red is chosen as the most convenient because the first light rays which a heated body emits, when its temperature passes 525 deg. C., are red. As the temperature grows, the maximum intensity of radiation moves gradually along the spectrum to the waves of shorter length, and the colour of the heated body changes from red to orange and, finally, when all the colours are represented, to white. But the longer light-waves, producing in the eye the sensation of red, which alone can pass through the glass wedge, continue to increase in intensity with the increasing temperature. For a "black body" the intensity of radiation depends entirely on the temperature, and the intensity once determined, by noting the exact point on the wedge where the image of the heated object disappears, the temperature of a "black body" can be immediately read on the accompanying scale, which has been calibrated under "black body" conditions. But for a "non-black body" the intensity is less than for a "black body" at the same temperature, being multiplied by the coefficient of absorption, and therefore the same intensity corresponds to a higher temperature for a "non-black body" than for a "black body." Hence, any kind of optical or radiation pyrometer will read too low for a "non-black body" in the open. For example, an optical pyrometer using red light, if applied to measure the temperature of a piece of iron and a piece of porcelain, which were each at a temperature of 1,200 deg. C., in the open, would register a temperature of 1,140 deg. C. for the iron and 1,100 deg. C. for the porcelain.

Fortunately for industrial pyrometry, a furnace in which the temperature is approximately constant has all the radiation properties of a perfect "black body," and the temperature of such a furnace may therefore be accurately registered by a pyrometer like the "Wedge," which has been calibrated under "black body" conditions.

Iron and Steel Production in Italy.

In a booklet entitled "The Economic Revival of Italy," recently published by the Unione Tipografico, Editrice Torinese, a detailed survey of the principal Italian industries and public services is given, showing



Italian Iron and Steel Output for 1881 compared with that for 1913.

the developments that have taken place during the past 32 years.

The accompanying illustration draws a comparison between the iron and steel outputs of 1881 and 1913 respectively.

THE HENDON JIG & TOOL COMPANY, LIMITED, has been established at Colindale Avenue, Hendon, London, N.W., to specialise in pattern making.

Timber for Patternmaking.

By James Edgar.

The efficiency of the pattern-shop depends to a very great extent on the timber used. Twenty years ago better timber was used for pattern-making than is used to-day. There has been, in recent years, a growing tendency for firms to lower their pattern-making costs by using an inferior grade of timber. The wisdom of this is, however, very questionable. There is far more scrap with inferior timber, and it takes more time to work up. The jobbing pattern-shops, where economy is a prime consideration, realise this, and very often they use better timber than the large shops. It is necessary, however, to use good timber for all classes of work. In most shops there are two or three different grades of patterns, those from which hundreds of castings will be made, others which will be used very occasionally, and the cheapest class, which are for one-off jobs. If cheap, unseasoned timber is used for standard patterns, they soon become unreliable and have to be re-made; hence the first saving will be an ultimate loss. But it is undoubtedly waste to use really good timber for skeleton work.

Every pattern-shop, with the exception of motor shops, where only the best timber is ever admissible, should stock two grades of timber, and they ought to be stocked separately. Of course, no craftsman will use cheap timber if he can avoid it, but the foreman ought to consider it a duty to keep a close watch on the timber. It is regrettable that foremen pattern-makers so often neglect this. In a large shop the foreman is probably too busy to trouble about the timber shed, but there ought to be a man in charge.

Yellow pine is undoubtedly the best timber for pattern-making. Before the war, with a view to economy, spruce was occasionally used, but generally the firms who experimented with spruce soon reverted to yellow pine. Yellow pine is straight-grained, it is soft and easily worked, and it takes varnish. Spruce, on the other hand, is loose-grained, it is more brittle, and is more sensitive to atmospheric conditions. Some years ago sypress looked like becoming popular, but it warps very readily, and if carving has to be done it is not satisfactory. One great advantage it has is its width and freedom from knots. The writer has used almost every kind of hard wood for small standard patterns, and mahogany, or, rather, baywood, surpasses, in his opinion, all other kinds. Teak is sandy and takes much more time to work than baywood. Beech, sycamore, and maple, of course, make good patterns, but they are very hard, although, if the major part of the work has to be done in the lathe, any one of these woods is better than baywood, and they turn easily.

The growing scarcity of yellow pine has presented a very serious problem to pattern-makers. Some firms are attempting to solve it by the temporary adoption of good spruce. It is not a question of first or last costs just now, but of necessity, because spruce is high-priced these days. The unfortunate thing is that more old patterns are not re-used. Where there is a stock of old patterns, and nearly every pattern-shop accumulates such a stock, there is a great deal of valuable timber that could be re-used. It is not an exaggeration to say that there are some pattern-shops in the country which could keep going for a long time without using one new board of timber. Many of these old patterns are obsolete standards, and will probably never be wanted again, and especially if they have been stored in sheds the timber is dry and superior to new. The unscrewing of old patterns takes time, of course, but it can be done by unskilled labour. If barrels were sorted out according to their diameter, and frames and other pieces of timber were arranged and classified properly, the timber difficulty would not be so great. Lastly, there is room in every pattern-shop, whether large or small, for scrap-heaps. A great many band and circular saw cuttings, which are burned, could be used. Economy in the use of timber, as in other things, is very largely a habit.

PATENTS IN RELATION TO HISTORY.—At a conference on the relation of patents to industry, held at the British Scientific Products Exhibition on July 31, Lord Moulton presiding, Sir Robert Hadfield said the Federation of British Industries, which was dealing with this question, was backing up the views that had been expressed by the conference of scientific and technical societies which had already gone into the question in regard to the new Patents Bill. They agreed (1) that there should be a much longer term for the life of patents; (2) that the "file wrapper" system should be adopted, as was the case in America (this allowed an examination of the various remarks by the Examiner on any particular application); (3) the constitution of a special tribunal for dealing with patent actions; and (4) an extension of the term of provisional protection from six months to two years. It seemed an anachronism in these days to find that a Britisher could not get as good and as long a patent as an American. An American patent commenced, not from the date of application, but from the date on which the patent was actually granted, whereas in this country we might waste twelve or fifteen months and all that time the life of the patent was running. With regard to fees it was agreed that if fees were reduced by 50 per cent. it would be a very great advantage. As to Empire patents, he agreed with the view of the Federation that it was too late to do anything in this matter in regard to the new Patents Bill, and that for the moment that point should not be pressed. A point which the Federation was introducing was that the publication of a paper before a learned Society should not be taken as in any way barring a man from getting a patent.

RAILWAY SPRINGS AND TYRES.—Dr. Hatfield in his recent Paper read before the Institution of Mechanical Engineers on "The Mechanical Properties of Steel," referred to the subject of springs and tyres for railway vehicles. With regard to springs, he stated these had to withstand considerable elastic deformation and reversal of stress, including shock, for indefinite periods. Experience had resulted in quite a hard steel being employed with a high maximum stress, yield and elastic limit and with relatively little ductility. As to tyres, it was found that success was attained by using a somewhat high-carbon steel, *i.e.*, one with a pearlite matrix. This resulted in a relatively high maximum stress with a correspondingly wide elastic range. The most excellent tyres which have proved extremely efficient in service had, under the notched bar test, a low notched impact value. The drop test was employed in passing tyres, and it occasionally happened that a tyre would fail under this test. It was an astonishing fact that in some cases the tyres which failed had a higher notched impact value than those which withstood the specified test.

Trade Talk.

George Richards and Company, Limited, will shortly commence the building of a new foundry at their Broadheath Works, Cheshire. The building is to be 290 ft. by 130 ft.

Mr. A. S. Grunspan, who severed his connection with Edmond Coignet, Limited, in April last, has set up in practice as a consulting engineer at 8, Victoria Street, Westminster, S.W.

The requisite 80 per cent. of the shareholders of William Jessop & Sons, Limited, having accepted the offer made by the Birmingham Small Arms Company, Limited, the amalgamation of the two concerns is now an accomplished fact.

The Birmingham Small Arms Company, Limited, will next month commence the manufacture of a 12-bore hammerless double-barrelled shot gun. Factory space has been allotted and other preliminaries arranged for an initial output of 100,000 complete guns, at the rate of 2,000 to 3,000 a week.

A meeting of Muntz's Metal Company, Limited, held at Birmingham, under the chairmanship of Mr. A. H. Wiggin, confirmed a resolution passed at a previous meeting that each of the existing 24,000 preference shares of £5 each and 50,000 ordinary shares of £5 each be divided into five shares of £1 each.

The firm of Raine & Company, Limited, iron and steel manufacturers, Winlaton Mill and Derwenthaugh, entertained their employés to a peace dinner at Newcastle, when opportunity was taken to present the manager, Mr. N. Rayne, with a token of respect and esteem from the workers

In view of the amount of iron and steel being imported into the United Kingdom from America at the present time, it is of interest that the Charcoal Iron Company, Limited, of Ulverston, have booked several orders for their "Lorn" charcoal cold blast hematite pig-iron from the United States.

A meeting of the "B" debenture stockholders of the Canada Iron Foundries was held on August 27, at which proposals were made for the conversion of the "B" stock. It was proposed that holders should accept £45 cash and 300 par value of preferred shares for each £100 par value of debenture stock.

The executive of the Iron and Steel Trades Confederation have permitted Mr. J. Hodge, M.P., to visit America for the purpose of inquiring into the iron and steel trade in that country, and to report to the Confederation on the working conditions and on other matters. Mr. Hodge is expected to leave this country in October.

According to M. R. Pinot, of the Comité des Forges de France, the output of electric steel in France has increased from about 21,000 tons in 1913 to 54,000 tons in 1917, and 58,000 tons in 1918. The number of electric furnaces was 24 before the war, and 21 more have been erected during the war, which, according to M. Léon Guillet, have an output capacity of 55,670 tons.

Following the announcement by the Hon. C. Ballantyne, Canadian Minister of Marine, to the effect that a new contract had been entered into between the Dominion Government and the Dominion Steel Corporation for the delivery, within a five-year period, of 250,000 tons of ship-plates, it is stated that work on the mill at Sydney (New Brunswick) will be resumed immediately.

The capital of the Consett Iron Company, Limited, is to be increased from £1,500,000 to £3,500,000, the shareholders having recently passed the necessary resolutions. The directors propose creating 2,000,000 new ordinary shares of £1 each taken from the undivided profits, which will be distributed to the existing ordinary shareholders in the ratio of two new shares for each share held.

The large extensions at the Mossend Works of William Beardmore & Company, Limited, are nearing completion, and the 32-in. section mill, which we believe is the largest in the country, will probably commence rolling operations early this month. This mill has been laid down on the most modern lines and is capable of giving an output of at least 4,000 tons per week of steel angles and sectional material.

Mr. Summers Hunter, managing director of the North-Eastern Marine Engineering Company, Limited, on August 8, formally opened the new canteen, which the company has built at their Wallsend Works for the benefit of their workpeople. The new canteen will provide seating accommodation for about 670 persons. The buildings, which are of a substantial and up-to-date character, comprise two dining halls, respectively about 124 ft. x 40 ft. and 38 ft. x 40 ft., with central kitchen, sculleries, stores, heating chambers, etc.

In the United States an apparatus bearing the name of the Detectorphone has been devised for detecting the presence of loose parts in machinery. It operates on the principle of the telephone, and any unusual noise coming from the interior of machinery, such as that caused by nuts having worked loose, etc., may be detected. The instrument is also being used to detect leaks in buried water pipes. In this case an iron rod is driven in over the pipe and the machine placed on the end of the rod. In case of a leak a gurgling sound is then audible, which enables the leakage to be located.

Extensive developments are projected at the lead and zinc mines of the Lake Country. The whole of the bearing ground in the extension to the old mine at Threlkeld of about 97 fathoms has been found to be payable ground, and the contents will average about one ton of lead to the fathom. At the Brundholme Mine, Mr. W. H. Borlase is engaged in sinking a new shaft, which is already down 35 fathoms, and is to be carried a further 20 fathoms, when lateral development will be undertaken. Mr. Bennett Johns is opening out the Goldscope lodes in the Newlands Valley, and it is anticipated will reach the intersection of the copper vein and Sealby's code. The total length of this adit level is 1,800 ft.

The Cleveland Institution of Engineers and the North East Coast Institution of Engineers and Shipbuilders propose establishing a technical institute in Middlesbrough. On the recommendation of a joint committee, the Methodist New Connexion Chapel in Corporation Road, Middlesbrough, has been acquired for the purpose. It has a total area of 1,200 sq. yds. and comprises a main hall and five other rooms on the ground floor, with a lecture room on the first floor. It is intended that the building shall become the headquarters of the Cleveland Institution of Engineers and the local section of the North East Coast Institution of Engineers and Shipbuilders and of other technical societies in Middlesbrough and district.

The meeting of the executive of the Iron and Steel Trades Confederation in London on August 14, under the presidency of Mr. John Hodge, M.P., discussed the question of foreign trade, with particular reference to American competition in the iron and steel industries. The view was held that the matter was one in which both workmen and employers should lay their cards on the table. Frankness with one another was required, both in respect of the profits which were made in the trade and as to whether the present prices charged by the manufacturers were justified. It was thought, moreover, that there should be improved methods in respect of the organisation of the industry —for instance, in the allocation of orders, the pooling of freightage, etc.

The current report of the Iron and Steel Trades Confederation states that the American iron and steel industry is many years behind the British industry, so far as the relations between employers and workmen are concerned, and the recognition of the right of organisation and the establishment of machinery of negotiations as

between the employers and workmen's organisations. Apparently, however, the report states, the experiences of the war have had some modifying influence on the attitude of the American employers, and while it has been the practice in the past to deny the right of combination to the workpeople, the employers have now adopted what is known as the "open shop," which is to say, the employés are free to join a trade union, but there is no recognition of trade union bodies as the negotiating factor where the interests of the men are concerned. Representatives from the United States at present in this country on commissions of inquiry have expressed surprise at the difference in the relationship between the representative unions in the iron and steel trades and the employers, and the success of the machinery of negotiation, as against what obtains in America. It is a matter, however, says the report, which the workmen would require to solve for themselves.

THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION is being organised to secure the fullest possible benefits from scientific and industrial research and information which are essential for the present and future progress of all industries concerned in the production, treatment, manufacture, and use of non-ferrous metals. The association will have the support of the Department of Scientific and Industrial Research. The association will encourage and develop technical efficiency in the production, treatment, and utilisation of non-ferrous metals and alloys, by the promotion and application of scientific and industrial research, and also institute an information bureau of all important technical and scientific information directly or indirectly relative to the non-ferrous metals industries of the British Empire. A provisional committee of the association is now at work, and is chiefly composed of members who have been appointed as representatives of the various existing trade associations. It is intended at an early date to obtain suitable quarters for housing an information bureau, to appoint a staff, and to establish branches in various centres of the country. The offices of the Provisional Committee of the British Non-Ferrous Metals Research Association are at 30, Paradise Street, Birmingham.

IN the course of a circular sent to shareholders the Birmingham Small Arms Company, Limited, state that the manufacture and supply of small tools is closely connected with the supply of machine tools, and with a view to the development of this trade the directors have acquired the business of C. W. Burton, Griffiths & Company, Limited, agents and dealers in British and American machinery. The directors have now to report a further important acquisition. Every branch of the company's business depends largely upon the supply of steel of special qualities, and for many years the principal source from which the company has drawn these materials has been the old established firm of William Jessop & Sons, Limited, of Sheffield. With a view to still further consolidating this close connection and of broadening the basis of their trade, the directors considered it advisable to enter into negotiations with the directors of the Jessop Company, and the negotiations culminated in an offer for the purchase of the whole of the ordinary and preference shares of the Jessop Company on terms which involved a sum of about £1,400,000, payable either in cash or partly in cash and partly in preference and ordinary shares to be issued by the Birmingham Small Arms Company, Limited. For the purpose of this offer the Small Arms 6 per cent. preference shares were valued at par and the ordinary shares at £2 per share. The directors' offer has now been accepted by more than the minimum number of shareholders stipulated for. The new shares, both preference and ordinary, to be issued by the Small Arms Company to the Jessop shareholders will rank for dividend from August 1, 1919. The directors anticipate that the fusion will bring an accession of strength to both firms.

EXCELLENT prices were obtained recently at the sale of machinery and plant at the National Projectile Factory, Tinsley, of Thomas Firth & Sons, Limited. The approximate receipts were between £17,000 and £18,000. One 5-cwt. pneumatic power hammer, coupled to a 14-B.H.P. motor, realised £480, and was originally purchased for £339. One 10-cwt. pneumatic power hammer and motor was purchased for £570, against the original cost of £538. A No. 1 "Lumsden" oscillating tool grinder fetched £80. A 200-B.H.P. rotor and stator, made by the British Westinghouse Company, which, when new, cost £259, was sold for £350. Good bidding took place for one hydraulic accumulator, pressure 1,500 lbs. per square inch, made by Davy Brothers, Limited, and this eventually found a buyer at £700. A 20-ton road weighbridge, by Ashworth, Sons & Company, was bought for £250, and cost £140. Two vertical boilers were bought for £145 and £125 respectively, whilst a vertical pump, which originally cost £36, was sold for £44. A number of 300-ton double punch, double pot, hydraulic forging shell presses were sold at something like scrap prices, the figures obtained ranging from £130 to £185 each, whilst a number of large billet-heating furnaces fetched £50 each. A quantity of cast-iron floor plates, about 300 tons, found ready buyers at £7 10s. per ton, 8 ft. by 30 ft. air vessels, working pressure 60 lbs. per square inch, complete, with fittings, by Messrs. Davy Bros., realised £270, whilst a number of self-supporting steel chimneys were auctioned off from £55 to £70 each. A 50-ton vertical testing machine, with column and girder, by J. Buckton & Company, Leeds, which cost £590, was sold for £620, and centreing machines and racine hack saws found buyers at £18 and £19 and £31. One 3-phase induction motor, by the British Westinghouse Company, which cost £104, was sold for £120. One 4-wheel coupled saddle tank loco engine, made by Messrs. Hudswell, Clarke & Company, Leeds, which was originally purchased for £1,695, was sold for £2,500, whilst one loco engine, by Messrs. Barclay & Sons, was purchased for £1,650, against its original cost of £1,140.

THE COUNCIL OF THE CHARTERED INSTITUTE OF PATENT AGENTS draw the attention of those interested in the production of industrial property to Articles 306-311 of the Treaty of Peace. According to these articles extensions of time are given for performing any act for the maintenance or obtaining of patents, designs, trade marks, or other industrial property in enemy countries, and also in Allied countries, which ought to have been accomplished during the period of the war—that is, since August 1, 1914. Moreover, rights of priority under the International Convention which had not expired before August 1, 1914, may still be claimed

THE order recently placed by the London United Tramways, Limited, with the United States Steel Products Company for the supply of 2,500 tons of tramway rails has received considerable attention in the Press. In reference to this order Mr. John Hodge, M.P., says that the shipbuilders and bridge builders are all clamouring for steel, and so far as the tramway company is concerned, one cannot blame them for buying rails in the cheapest market. Everything is against us—the price of coal and the price of raw materials. Labour troubles are having their effect. The only thing is, we ought to protect our own market in the same way as the Americans do.

OWING to the scarcity and difficulty of obtaining carriage, the directors of the Consett Iron Company, Limited, have considered it prudent to purchase two steamers in order to secure the necessary and regular supply of ore to the blast furnaces. In conjunction with Guest, Keen & Nettlefolds, Limited, the company have purchased from the Public Trustee the shares in the Orconera Iron Ore Company, formerly belonging to Krupps. The directors have for some time been considering the question of reconstruction and expansion of the iron and steel plant of the company, and the erection of additional by-product plant, but all this is

for the moment held up by the uncertainty of the industrial position and the possible nationalisation of the collieries. The regular working of the steel works and rolling mills of the company has been much interfered with since April last by the coming into operation of an eight-hours day in the steel-making and steel-rolling plants, and it has not yet been found possible to work the whole of the plant under this system. The increased cost of this change bears very heavily on the company.

THE war record of Davidson & Company, Limited, Sirocco Engineering Works, Belfast, is an interesting one. A recently acquired extension of the works, the development of which was stopped by the war, was placed at once at the disposal of the military authorities, who made use of it as a drill ground during the early part of the war. A portion of the buildings was used by the Ministry of Munitions as an Inspection Bond, while another part was occupied by the Belfast and North of Ireland Employers' Munitions Committee which, under the chairmanship of Mr. S. C. Davidson, carried through a contract for 250,000 hand grenades. Later, the East Yard was occupied by the Royal Air Force, the buildings being used as a store for aeroplane parts. Shortly after the commencement of hostilities the company took up the manufacture of war materials, but "Sirocco" fans being urgently needed they were soon obliged to revert in a large measure to their standard manufactures. As indicating the extent of the demand the company point out that during the four and a half years they supplied over 8,000 "Sirocco" fans for use in the navy and mercantile service, 1,200 for induced or forced draft on land boilers, and furnished over 600 installations for heating and ventilating munition factories, etc. The following details are interesting:—Installations supplied to controlled establishments and industrial concerns.—289 heating and ventilating plants, 615 induced or forced draft plants, 136 dust removal plants, and 1,007 steam heater units for factory heating; food production—67 drying plants; coal production—234 mine fans; travelling field kitchens—100 in 1915 for the troops at the front; marine work—over 7,000 fans for the ventilation of warships, 102 forced draft sets for use on patrol boats, 933 fans for mercantile vessels, 54 fans for oil tank steamers, and 24 forced draft sets for standard ships; at the front—a number of machine gun periscopes, 46 fans for ventilating underground tunnels, hand-driven fans for ventilating dug-outs and machine gun emplacements, and inflating observation balloons, 591 fans for cooling the radiators on road vehicles, 879 for cooling the radiators and ventilating the interior of tanks, petrol-driven fans to deal with poison gas attacks, ventilating plant for 31 dope rooms, dust removal installations for woodworking departments of factories; explosives and munition factories—53 plants for drying gun cotton and other explosives, 425 fans for dealing with fumes, 281 heating and ventilating plants, 113 induced or forced draft plants, 33 dust removal plants, 23 plants for cooling electrical machinery, 183 fans for increasing the pressure of the gas supply to furnaces, 472 induced or forced draft fans for power stations, and 91 plants for cooling generators in power stations.

UPWARDS of 500 of the employés of Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield, joined the colours, and nearly 100 lost their lives. During the war all the workshops were crowded with war orders. New buildings were planned, laid out, built and equipped as fast as possible. The acreage of the works has been increased nearly 40 per cent. since 1914. More than 40,000 tons of castings were supplied to other munition factories for the production of articles so varied as paravanes, hydraulic shell-press cylinders, submarine electric motor and bedplate castings, motor-lorry wheels, parts of trench locomotives, tank-chain links and gears, etc., and others too numerous to mention. Tool steel was supplied to more than a dozen national shell factories. All the directors served upon numbers of committees and associations formed for the purpose of unifying the nation's output of war material. Technical members of the Edgar Allen Railway Track Department were lent to assist railway construction in France. The foundry manager went to the aid of the Ministry of Munitions. A part of the works covering an entire half-acre of ground was lent to the Government for a shell store, and more than five million shells passed through this warehouse from first to last. The directors were also largely instrumental in organising the replacement of German tungsten by an all-British product. Besides steel castings ranging in weight from a few pounds to ten tons, great quantities of circular saws for cutting hot and cold iron and steel, twist drills, ratchet plates for submarine mines, etc., were delivered on priority certificate for national shell factories and controlled establishments. Another responsibility which was taken over, and which contributed to the restriction on general delivery, was the building of steel furnaces for other makers. Early in the war, a group of officers raised a small and quite inadequate sum, with which the late Captain Smith, R.N., went to the Imperial Steel Works, asking for certain work to be done. The result—which cost several times the money raised for it—was the first wheeled protection used in the war. Perhaps this stimulated the evolution of the true tank form: but it was in no sense itself a tank, but only a bullet-proof shield, with a machine-gun mounted and loop-holes for rifle fire, which was moved forward by hand, the "crew" marching behind it. Later, orders began to reach the Imperial Steel Works for mysteriously-shaped armour plates, and, when the secret of them had been confided to the directors, for certain gears, sprocket wheels and forgings for epicyclic gears, calling forth an immense amount of new labour. This was supplied through the designing of certain jigs which enabled new and highly efficient machinery to be operated with comparative ease by women. They were the vitals of the greatest new invention produced by the war, during the war—the amazing and romantic tank. Aeroplane chains, so shaped as to protect a maximum of the flying man's bodily surface, were also produced. More than a million of shrapnel-proof steel helmets were delivered, likewise numerous bullet-proof shields. Contracts for parts of the Stokes gun—really a simplified mortar—were placed with Edgar Allen & Company, Limited. Steel castings for aeroplane bombs were also made at the Imperial Steel Works, and technical assistance given to other bomb makers, while large quantities of steel for howitzer carriages and mountings were also supplied. Thanks to the extension of research during the war, a very large variety of special alloy steels for aircraft construction was made available, including nickel steel, nickel-chrome steel, chrome-vanadium steel, and the non-rusting chrome valve-steel which proved so valuable in the construction of aircraft engines. Incidentally, the large consumption of chromium in these alloys removed from the market the stainless cutlery which began to be so popular just before the war. The engineering department, where various types of crushing and grinding machinery are built, is being greatly developed. Large numbers of ball mills were supplied during the war, for the treatment of the heavy chemicals used in munition making. To provide room for the extensions now in progress, the whole of the former very large tramway track department is being removed to a new site. Peace requirements in steel are being met, as fast as possible, by the extension of the foundry and tool-steel departments. An additional forge has been acquired, at Park View, Owlerton, for hammering and reducing tool steels and for forgings. New electric furnaces have been installed. Another development, the supply of powdered-fuel plants, is carried out in conjunction witht he Powdered Fuel Plant Company, Limited, 47, Victoria Street, London, who control the British rights of the Holbeck system as manufactured by the Bonnot Company, of America.

Parliamentary Notes.

Pre-War Practices.

On the motion for the third reading of the Restoration of Pre-War Practices (No. 3) Bill, MR. C. JONES supported the Bill from the standpoint of unskilled and general workers.

SIR R. HORNE said there was a section of the Bill which dealt with workmen in Royal establishments, and he had the command of his Majesty to acquaint the House that his Majesty, having been informed of the purport of the Bill, gave his consent, as far as his interest was concerned, that the House might do therein as they thought fit.

The Bill was then read a third time.

Patents and Designs Bill.

On the motion for the second reading of the Patents and Designs Bill, SIR A. GEDDES said it was very urgent, now that they were everywhere restarting trade, that some of the provisions of the Bill should be carried into law. The second clause of the Bill instituted a new form of patent. It was hoped that the inventor who had difficulty in getting capital to work his invention would have it taken up and his interests looked after. There was also a series of provisions which it was hoped would be in the interests of the public in relation to the monopoly which the granting of a patent gave. It was also intended to meet the abuse which the granting of a patent to a foreign inventor sometimes gave rise when the manufacture of the article in this country was not on a commercial scale. There was in Clause 6 a very important provision with regard to the duration of the protection. It was proposed to raise it from fourteen years to sixteen years, the reason being that during the war it had been impossible to get many patents to work.

The Bill was read a second time.

The Export Trade.

In the House of Commons recently, Sir A. GEDDES, President of the Board of Trade, said that he was fully aware of the urgency of re-establishing British export trade to the countries which were not in a position to pay at present by means of exports for essential imports. A scheme had been prepared in consultation with banking and trading interests under which the Government would set up an office to provide sterling credits in approved cases where it was found impossible to obtain sufficient facilities through the ordinary business channels. It was hoped that certain representatives of those interests which had already been consulted would be willing to assist the office in an advisory capacity. Full particulars of the scheme would be made public as soon as certain outstanding points of detail had been settled.

Trade Marks Bill.

On the motion for the second reading of the Trade Marks Bill, SIR A. GEDDES said that under the first part of the Bill it was intended to have a list or register of trade marks which had common law existence. It was proposed in Part "B" to have a register of trade marks into which it would be easier to get trade marks than into the register in Part "A." The second part of the Bill had very considerable practical importance, for there was a great abuse at the present time in connection with the use of the word "trade mark." The Bill was read a second time.

Rolling Stock Abroad.

Generally speaking, the rolling stock sent abroad was supplied on loan by the railway companies, MR. FORSTER stated in the Lower House recently. There was no special remuneration for its use apart from the general terms of the Government guarantee to the railway companies. On its return to this country, the stock was put into condition at the expense of Army funds, and the War Department had the right to consider the extent and cost of any work proposed for this purpose before it was undertaken, and, in case of dispute, to refer the matter to arbitration.

Committee on Trusts.

MR. BRIDGEMAN recently stated that the publication or ommission of names in a Report such as the Committee on Trusts must necessarily be left to the discretion of the Committee itself, having regard to the particular circumstances of the inquiry. The course taken by the Committee in this particular instance was due to the fact that much of the information before them was obtained confidentially. The desirability of giving the names in future investigations into the operations of trade combinations would be borne in mind.

Railmaking.

MR. T. THOMSON asked the President of the Board of Trade recently whether he was aware that many British railmakers would shortly not have enough work to keep their mills running at their full capacity; and if he could do anything to facilitate the placing of orders by Home railways, as those orders were apparently being withheld for some reason.

SIR A. GEDDES: I understand that British railmakers are very busy at present, but I am drawing the attention of the Railway Executive Committee to the point.

Control of Water Power.

In reply to Sir Robert Thomas, SIR AUCKLAND GEDDES has stated that he is considering the question of introducing legislation of an interim character providing for the control of water-power developments. The Aluminium Corporation have applied to the Board of Trade for an extension by one year to the period of three years fixed by the Conway and Colwyn Bay Joint Water Supply Board Act, 1916, for the completion of the dam of Lake Cowlyd.

Patents and Designs Bill.

The Patents and Designs Bill, as amended in Committee, was considered on report in the House of Commons on August 7. The report stage was concluded, and the Bill was read a third time.

National Smelting Company, Limited.

MR. HOLMES was recently informed by MR. BRIDGEMAN that the arrangements made between His Majesty's Government and the National Smelting Company in 1917 had not so far been modified in any respect. The whole question of the future of the spelter industry in this country was receiving very careful consideration. He was not at present able to announce any decision on the matter.

Horbury Wagon Works Dispute.

In the Lower House, MR. MARRIOTT asked whether it was the case that the Railway Vehicle Builders' Union, while admitting that they had no members unemployed, had refused to allow a certain firm to employ discharged soldiers, on the ground that they were not members of the Union, and likewise refused to admit them into the union.

SIR R. HORNE said he presumed the dispute which had arisen at the works of Charles Roberts & Company, Limited, at Horbury, was referred to. He was in communication with the Union in question on the subject.

In connection with the above statement by Sir Robert Horne, it is interesting to note that Charles Roberts and Company, Limited, announce that as long ago as April 1 they placed all particulars concerning the Horbury dispute before the Minister of Labour. Although several communications had been sent to Sir Robert Horne, no reply had been received later than May 12.

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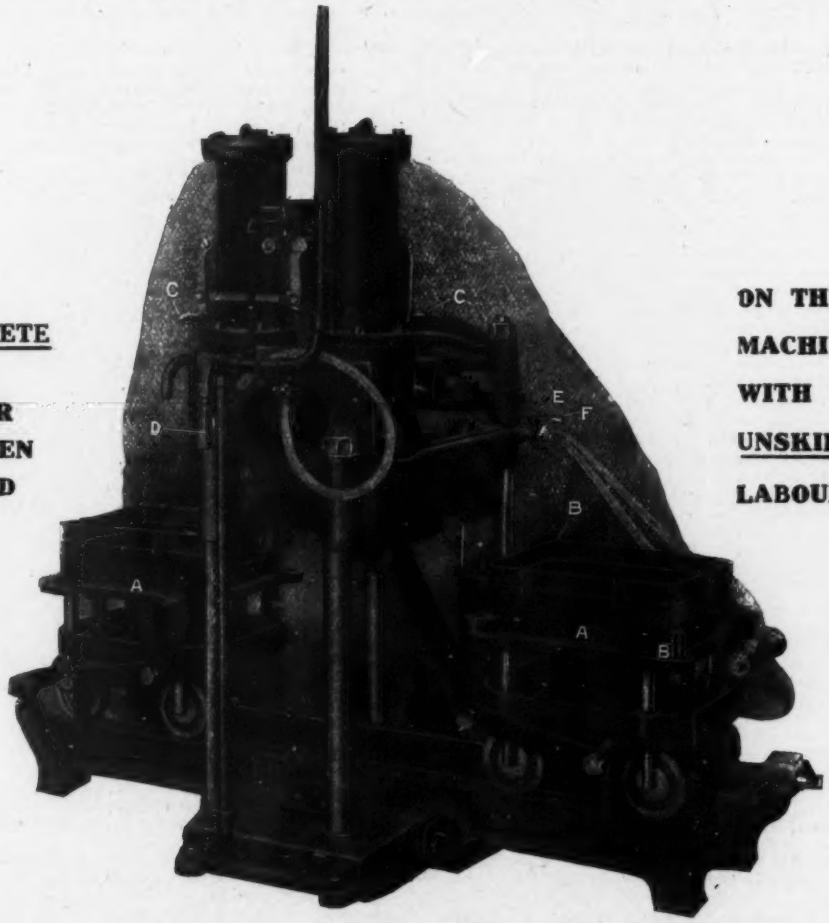

ON THIS MACHINE WITH UNSKILLED LABOUR.

One of many that we have installed in various Munition Work Centres.

JAMES EVANS & CO., BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

The Horbury Dispute.

MR. WARDLE announced on July 17 that a strike had occurred at the works of Messrs. Roberts & Company, Horbury Junction, because the firm introduced certain unskilled ex-Service men on skilled work without previous arrangement with the trade union concerned. He was not aware that the question whether the ex-Service men should join the union had been raised. The Interim Industrial Reconstruction Committee for the industry, who had been consulted about the employment of ex-Service men, did not support the firm's action. I have put before the union a proposal agreed with the firm as to the conditions under which ex-Service men should undertake the work proposed by this firm.

Personal.

THE late Mr. F. S. Jopling, steel manufacturer, of Thornhill Terrace, Sunderland, left estate valued at £15,148.

THE late Mr. W. Boyd, managing director of the Wallsend Slipway and Engineering Company, Limited, left estate valued at £66,756.

MR. H. ELLIOTT, of "Avondale," Whitby, near Birkenhead, has been appointed chief engineer to a large group of collieries in India.

MR. A. PAGE has been appointed general manager of the Clyde Valley Power Company, Limited, in succession to the late Mr. D. A. Starr.

THE late Mr. J. H. Parkes, of A. & F. Parkes, Limited, edge tool manufacturers, Birmingham, left £41,968, the net personalty being £8,360.

THE late Sir Archibald D. Dawnay, of Archibald Dawnay & Sons, Limited, engineers, London and Cardiff, has left estate of the value of £93,154.

MR. A. FORSHAW, chief chemist to Messrs. John Wright & Company, has been appointed to a similar position with Fletcher, Russell & Company, Limited.

MR. F. W. LEWIS has resigned his position of production engineer of Ruston & Hornsby, Limited, and has joined the General Electric Company, who are the proprietors of Fraser & Chalmers' Engineering Works, Erith.

MR. FRANK ENTICKNAP, of Bellwood, Guest Road, Prestwich, Manchester, has severed his connection with Messrs. Hall & Pickles, and is now representing Messrs. Robt. Heath & Son, Limited, of Stoke-on-Trent, in Manchester.

THE Staffordshire Education Committee have appointed Mr. R. C. Watson as assistant to Dr. Fisher in the Engineering Department of the County Metallurgical and Engineering Institute, Wednesbury. Mr. Watson served his apprenticeship in the works of the Westinghouse Company, Manchester, and received his science training at Sheffield University.

In recognition of the voluntary services rendered by Mr. D. M. Urquhart, managing director of Menzies & Company, Limited, Leith, as district superintendent of ship repairs, Admiralty, the shipbuilders, ship-repairers, engineers, and others in the Forth district entertained Mr. Urquhart to a complimentary dinner Mr. A. J. Ferguson, of Ramage & Ferguson, Limited, shipbuilders, Leith, who presided, presented an inscribed silver salver in the name of the subscribers.

MR. W. H. MEADOWCROFT, senior vice-president of the Lancashire Branch of the British Foundrymen's Association, has recently been appointed foundry manager for Messrs. Mirrlees, Watson & Company, Limited, of Glasgow. Mr. Meadowcroft was the recipient of several presents from the staff and foremen of Messrs. R. & J. Dempster, Limited, Manchester, and from numerous friends. At a large social gathering at the Duke of York Hotel, Newton Heath, Manchester, Mr. Meadowcroft was given a hearty send-off Manchester foundrymen recognise that they have lost one of, if not the most, popular members of the Lancashire branch of the B.F.A.

Legal.

Alleged Defective War Material.

Charges under the Defence of the Realm Regulations against W. S. Laycock, Limited, Sheffield; J. Sedcote, general manager of the engine department; F. Miller, late commercial manager of the firm; W. Hunter, works manager; E. Clarke, foreman fitter; and W. Margerison, stores clerk, of intending to mislead the Air Ministry as to the quality of certain war material, have been recently heard at Sheffield. T. Durnan, secretary of the company, was also summoned, but not in his personal capacity. The evidence for the prosecution was that the workmen in the employment of the defendant company were instructed, when the staff of the Aeronautical Inspection Department had left the works, to substitute for a number of cylinders which had been approved by the inspectors, cylinders which had not passed the inspectors. The workmen carried out their instructions, and when a consignment of 167 cylinders was inspected in London it was found that 117 of them had serious defects in the port holes, and 86 out of the 117 had traces of having been subjected to an engine test. The consignment had been marked for acceptance, and it was only by very close examination that the defects were discovered.

For the defence it was urged that the firm had no knowledge of the substitution.

The Bench convicted, and fined the firm £200 and ordered them to pay 100 guineas costs. J. Sedcote, general manager of the engine department, was fined £50; F. Miller, formerly commercial manager, £10; W. Hunter, works manager, £20; E. Clarke, foreman fitter, £2; and W. Margerison, £30.

Marshall & Company v. Nicholl & Son.

The House of Lords have dismissed the appeal of Nicholl & Son, iron and steel merchants, Dundee, in the action against them by Marshall & Company, Glasgow, for damages as a result of appellants' failure to implement sales of steel sheets. Lord Hunter awarded the Glasgow firm £2,000 damages. On appeal the Second Division of the Court of Session found that the whole of the contracts had been established, and awarded £3,475 as damages. The appellants sought to establish that no contracts were, in fact, concluded between the appellants and the respondents, and that, even if contracts were concluded, in which case it was admitted that they were broken, the respondents had failed to prove that they suffered any loss or damage by reason of the breach.

Viscount Finlay, Viscount Cave, and Lords Dunedin, Shaw, and Wrenbury agreed in dismissing the appeal.

Deaths.

MR. W. H. TRIPPETT, of Sharrow, died on July 20 The deceased gentleman entered the service of Henry Bessemer & Company, Limited, about thirty-five years ago, and for a considerable number of years was chief clerk, whilst in 1912 he was appointed secretary to the company.

THE death is announced of Mr. J. R. Holliday, who for many years was a partner in the firm of Thos. Harbut & Company, galvanisers. For over 50 years the firm conducted business in North Shields, and about 20 years ago, on its being formed into a limited liability company the business was taken further up river to Walker-on-Tyne. The deceased gentleman retired at that time.

THE death occurred on Wednesday, August 13, at his residence, Beeches Road, West Bromwich, of Mr. Joseph Belcher, director of the firm of J. B. & S. Lees, Limited, of the Nelson Ironworks, West Bromwich. Mr. Belcher, who

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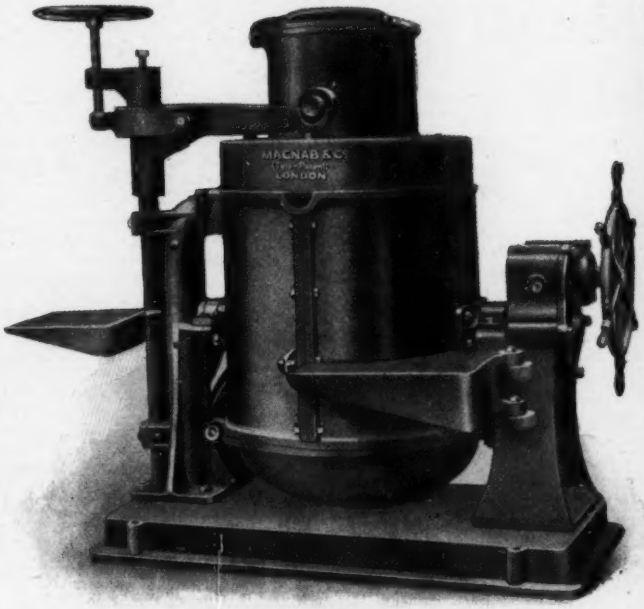


Tylor Patent Pit-Type Furnace.

OUTPUT.

200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.

ECONOMY.

25 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 35 to 40 heats.

Tilting-Type Furnace.

OUTPUT.

450 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.

ECONOMY.

56 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 35 to 40 heats.

was 62 years of age, had for many years been a prominent figure on the Birmingham Iron Exchange, where he was held in the highest esteem. For practically the whole of his life he had been associated with the firm of J. B. & S. Lees, of West Bromwich. Joining them as a young clerk, he eventually became manager—during the absence of Major J. Lees on active service he had entire control of the large business—and when it was converted into a limited liability company in 1917 he was elected a director.

Applications for Patents.

Aktiebolaget Kvafveindustri. Heating material or performing chemical processes in electrical furnaces. 17,821. July 16. (Sweden, April 12.)

Astbury, F. Handling ingots, etc. 17,565. July 14.

August, J. R. C.—Means for annealing, tempering, etc., metal bars, etc. 18,097. July 21.

Bates, F. G., and Evetts, G. A. Casting metal tubes, etc. 17,703. July 15.

Baxter, Limited, W. H., and Baxter, W. H.—Adjustable bearings for elevators for raising stone, ore, coal, etc. 18,291. July 23.

Bengtzon, R. R. B. Twisted boiler tubes. 17,621. July 14.

Cleveland Bridge and Engineering Company. Apparatus for cutting bolts, rivets, etc. 17,903. July 17.

Cummins, F., and Mooney, F. Combined coal and water gas plants. 17,654. July 15.

Flett, J. W., and R. Wire, etc., making machines. 17,721. July 15.

Graham, W., and Honeywood, D.—Machinery for crushing or grinding ore, rock, cement, etc. 18,120. July 21.

Hancox, E. Machinery or apparatus for manufacture of metal plates or sheets. 17,984. July 18.

Hansen, H. E. Machines for manufacture of single-wire barbed wire. 17,755. July 16. (Denmark, July 15, '18.)

Leathart, T. H., and Locke, Blackett & Company. Refining lead. 17,785. July 16.

Mehren, A. A. L. I.—Moulding-machine. 18,209. July 22.

Metals Extraction Corporation. Treatment of zinc solutions. 17,929. July 17.

Moore, J. B.—Manufacture of tools of high-speed metal. 18,264. July 22.

Morgan, E. H.—Smoke-consuming fire-grates, furnaces, etc. 18,494. July 25.

Oddy, C. Fastener for nuts and bolts. 17,585. July 14.

Priest & Mullings, Culliford, C. H. H., and Mullings, W. J.—Machine for recoiling barbed-wire. 18,659. July 21.

Réol, J.—Apparatus for dehydrating, reducing, calcining, or roasting minerals, etc. 18,584. July 26. (France, August 9, 1918.)

Robertson, N. D. G., and Sheppard, C. H.—Manufacture of composite sheets of metal. 18,474. July 25.

Stolp, F. H. Formation of sheet-metal tubing. 17,618. July 14. (United States, May 12, '17.)

Stolp, F. H. Machinery for forming sheet-metal tubes, etc. 17,619. July 14. (United States, May 12, '17.)

Thompson, J., and Thompson, W. J.—Method for coating iron, steel, etc., with aluminium, etc. 18,498. July 25

Wale, W. F. Read-. Composition for coating metals with tin or tin alloys. 17,573. July 14.

Wellman Smith Owen Engineering Corporation. Continuous reheating-furnaces. 18,048. July 18.

New Companies.

Crawford Lighterage Company, Limited. — Capital £5,000 in £1 shares.

Mount Motors, Limited.—Capital £5,000 in £1 shares. Registered office: Cardiff Road, Mountain Ash, South Wales.

Manufacturers' Service Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers.

Lattimer Engineering Company, Limited.—Capital £2,000 in £1 shares. Registered office: 25, High Street, Brentwood.

Allied Machinery Company, Limited. — Capital £50,000 in £1 shares. Registered office: 18, Birchin Lane, E.C.

Cinderford Consolidated Iron Mines Limited.—Capital £15,000 in £1 shares. Registered office: 12, Mark Lane, E.C.

Britannic Metal & Galvanising Company, Limited.—Capital £2,000 in £1 shares. Registered office: 17, High Street, Bargoed.

Swinnow Engineering Company, Limited.—Capital £5,000 in £1 shares. Registered office: Swinnow Lane, Bramley, near Leeds.

Barron Pearson Engineering Company, Limited.—Capital £10,000 in £1 shares. Registered office: 35, Rydal Street, Leicester.

Norlow Engineering Company, Limited. — Capital £25,000 in £1 shares. Registered office: 4, Stone Buildings, Lincoln's Inn, W.C.

James W. Smallman, Limited.—Capital £20,000 in £1 shares, to take over the business of engineers, etc. Registered office: Blackdown Manor, Leamington.

Davis & Brocklesby, Limited.—Capital £7,500 in £1 shares, to carry on the business of brassfounders. Registered office: 147, Radnor Street, Hulme, Manchester.

G. Welford & Son, Limited.—Capital £25,000 in £1 shares, to carry on business as engineers, etc. Direc- Registered office: 40, West India Dock Road, Limehouse, E.

Cooper & King, Limited.—Capital £1,000 in £1 shares, to carry on business as sheet-metal workers. First directors: R. G. Cooper and C. King. Registered office: Coventry.

Grove Metal Renning Works, Limited.—Capital £2,000 in £1 shares. First directors: A. G. Edwards, F. M. Garnham and W. J. Stanneld. Registered office: 5, Fen Court, E.C.

A. Macaulay & Company, Limited.—Capital £6,000 in £1 shares, to acquire the business of metal merchants and refiners at Moorpark Smelting Works, Renfrew.

Hemingway's Chemical Processes Company, Limited.—Capital £30,000 in £1 shares (25,000 6 per cent. non-cumulative preference). Registered office: 15, Seething Lane, E.C.

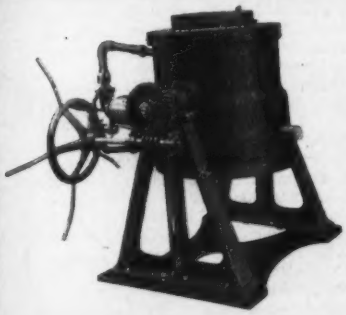
Premier Electric Welding Company, Limited.—Capital £75,000 in £1 shares, to acquire the business carried on by J. Crichton as the Premier Electric Welding Company.

Ferryhill Foundry & Engineering Company, Limited.—Capital £3.000 in £1 shares. First directors: E Taylor, E. Putnam, and H. Forrest. Registered office: Ferryhill, Durham.

Gilstone Engineering Company, Limited.—Capital £30,000 in £1 shares, to adopt an agreement with W. V. Gilbert. Registered office: 92, Victoria Street, Westminster, S.W.

Brian Engineering Company, Limited. — Capital £10,000 in £1 shares. First directors: J. C. Brian, J. Brian, and R. J. Pugsley. Registered office: 35, Salisbury Road, Cardiff.

Britishers (Sheffield), Limited.—Capital £500 in £1



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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

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STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

shares, to carry on business as mechanical, electrical and general engineers, etc. First directors: J. H. Copley and W. Holmes.

British Machine Chain, Limited.—Capital £15,000 in £1 shares. Directors: A. F. Tero, C. St. Pierre, J. A. Robinson, and F. V. Robinson. Registered office: 95-7, Finsbury Pavement, E.C.

Mann & Allen, Limited.—Capital £2,000 in £1 shares, to take over the business of a brassfounder, etc., carried on by W. C. Mann at 87, Cheapside, Birmingham, as John Smith & Son.

J. Hadden & Company, Limited.—Capital £10,000 in £1 shares, to carry on business as electric light fitting manufacturers. Registered office: Haydn Park Works, Askew Road, Shepherd's Bush, W.12.

R. Sinclair & Company, Limited.—Capital £10,000 in £1 shares, to take over the business of metal and machinery merchants, carried on by R. Sinclair & Company, at Bonnington Road, Leith.

South of Ireland Electric (Arc) Welding Company, Limited.—Capital £2,000 in £1 shares. First directors: A. W. Spence, P. Fay and R. D. Whyte. Registered office: 26, Upper Abbey Street, Dublin.

Charles Humm, Limited.—Capital £5,000 in £1 shares, to carry on business as ironfounders, mechanical engineers, etc. First director: F. Knight. Registered office: Salisbury House, London Wall, E.C.

H. Edwards, Limited.—Capital £5,000 in £1 shares, to carry on business as iron, steel and metal merchants, etc. Directors: T. Woof, H. Edwards, and L. E. Parsons. Registered office: 64, Victoria Street, S.W.

V. Dugmore Lock & Company, Limited.—Capital £10,000 in £1 shares, to acquire the business of a brass cabinet lock manufacturer carried on by V. Dugmore at 21, Thornley Street, Wolverhampton.

Rustless Iron Company, Limited.—Capital £25,000 in £1 shares, to carry on the business formerly carried on by J. Smith and A. E. Berre as the Rustless Iron Company at Trico Works, Lawholme Lane, Keighley.

Clement Stevens Pneumatic Engineering Company, Limited.—Capital £35,000 in £1 shares (17,500 preference). First directors: C. H. Stevens and W. D. R. Jackson. Registered office: 56, Victoria Street, S.W.1.

Acton Aluminium & Bronze Company, Limited.—Capital £10,000 in £1 shares, to adopt an agreement with A. Webster. Permanent director: A. Webster. Registered office: Bank Buildings, 186, High Street, Acton.

Slag Products, Limited.—Capital £10,500 in 10,000 ordinary shares of £1 each, and 10,000 founders' shares of 1s. each, to acquire patent rights First directors: A. K. Dyer and G. W. Stotesbury. Registered office: 6, Lloyd's Avenue, E.C.

Hendon Jig & Tool Company, Limited.—Capital £5,000 in £1 shares, to enter into an agreement with H. Baume. Directors: W. Gunn, L. P. Tomlinson and H. Baume. Registered office: Collindale Works, Collindale Avenue, Hendon.

Albion Art Foundry, Limited.—Capital £10,000 in £1 shares, to acquire the business carried on by J. J. Marton at Albion Works, Parsons Green Lane, Fulham. Directors: J. I. Martin and J. F. C. Bell. Registered office: Albion Works.

Alfred Sheldon & Sons, Limited.—Capital £20,000 in £1 shares (10,000 6 per cent. cumulative preference), to take over the business of engineers, etc., carried on at West Street and Mill Lane, Wells, Somerset, as Alfred Sheldon & Sons.

N. S. Kilner & Company (Engineers), Limited.—Capital £1,000 in £1 shares, to take over the business carried on at Hepworth Chambers, Briggate, Leeds, as N. S. Kilner & Company. Permanent directors: N. S. Kilner and T. H. Speight.

Rotherham Steel Strip Company, Limited.—Capital £10,000 in £1 shares, to take over the business carried on by J. Beever, A. Beever, A. A. Charles, and W. Charles at the Bath Works, Westgate, Rotherham, as the Rotherham Steel Strip Company.

Millom and Askam Hematite Iron Company, Limited.—Capital £2,000,000 in 500,000 7 per cent. cumulative participating pref. and 1,500,000 ord. shares of £1 each, to take over the existing business. First directors: H. P. Geard and C. M. L. Carey. Registered office: The Works, Millom, Cumberland.

Wardrobe & Smith, Limited.—Capital £10,000 in £1 shares (5,000 preference), to take over the business of a steel manufacturer carried on by R. F. Wardrobe at the Arley Steel Works, Sheffield, as Wardrobe & Smith. Directors: R. F. Wardrobe (chairman and governing director) and P. Wardrobe. Registered office: Arley Steel Works, Arley Street, Sheffield.

Simplex Construction Company, Limited.—Capital £120,000 in 200,000 ordinary shares of 10s. each and 400,000 deferred shares of 1s. each, to enter into an agreement with J. Thame, the Chemical Engineering Corporation, Limited, and O. R. Mounsey. First directors: O. R. Mounsey and G. Lewis. Registered office: Parliament Mansions, Victoria Street, S.W.

Bates & Scholes, Limited.—Capital £100,000 in £1 shares, to take over the business of engineers carried on at Victoria Ironworks, Denton, by W. J. Bates & Company, Limited, now in liquidation. First directors: W. Scholes, W. N. Scholes, G. Bleakley, H. F. Tattersall, G. H. Roberts, J. Holt, and W. T. Hill. Registered office: Victoria Works, Denton, Lancs.

James Gray & Company (Camberwell), Limited.—Capital £2,000 in £1 shares, to acquire the business of engineers, etc., carried on at 29, Dalwood Street, Camberwell, as James Gray, and the business at 214, Southampton Street, Camberwell, as Gray & Banfill. First directors: J. Gray, W. H. Banfill, J. W. Hearn, and F. J. Gray. Registered office: 27, Dalwood Street, Camberwell, S.E.

SANKEY

Pressed Steel FOUNDRY LADLES Plain or Lipped

Let us know your requirements and we will quote you.

Joseph Sankey & Sons Ltd
Wellington ~ Shropshire

LEGGE'S IRON CEMENT.

The most efficient for general Engineering and Foundry Work.

It repairs permanently and effectively makes good all defects in Castings leaking parts and connections in Steam, Water, Gas and Air, etc.

WRITE TO MANUFACTURERS—

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Telegrams: "Durrans, Pennistone." Telephone: 21, Pennistone.

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

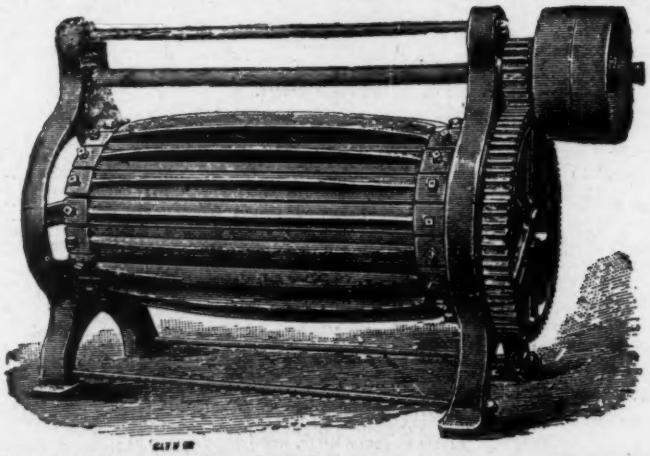
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself:—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

Pig-Iron.

	Home. £ s. d.
Hematite—	
East Coast Mixed Nos.	10 0 0
East Coast No. 1	10 2 6
West Coast Mixed Nos.	10 4 6
Scottish Mixed Nos.	10 10 0
Welsh Mixed Nos	10 10 0
Cleveland—	
No. 1	8 4 0
No. 3 foundry G.M.B.	8 0 0
No. 4 foundry	8 0 0
No. 4 forge	7 17 0
Basic	8 5 0
Derbyshire, Leices., and Notts—	
No. 4 forge	8 15 0
No. 3 foundry	9 0 0
No. 2 foundry	9 2 0
No. 1 foundry	9 4 0
Basic	9 2 6
Northamptonshire—	
No. 4 forge	8 5 0
No. 4 foundry	8 6 6
No. 3 foundry	8 7 6
No. 2 foundry	8 9 0
No. 1 foundry	8 11 0
Basic	8 17 6
South Staffordshire, Shropshire and Worcestershire—	
Part-mine forge	8 17 6
Part-mine foundry	9 0 0
Common Staffs.	8 12 6
All-mine forge	9 12 6
All-mine foundry	9 17 6
Warm-air forge	11 0 0
Warm-air foundry	11 10 0
Cold blast	14 0 0
Basic	9 2 6
Scottish—	
Foundry	9 15 0

NOTE.—The above prices are those fixed by the makers as a minimum for early delivery. In consequence of works being booked to capacity, makers are not committing themselves for later delivery.

Delivered in Manchester—	
*Derbyshire, No. 3	9 12 6
*Cleveland, No. 3	9 15 0
*Scottish, No. 3	10 5 0

* Merchant prices.

Delivered in Sheffield—	
East Coast hematite	10 7 6
Derbyshire basic	9 12 6
Lincolnshire basic	9 15 0
Do. No. 3 foundry	9 2 6
Do. forge	8 15 0

High-Speed Tool Steel.

	s. d.
Finished bars, 14 per cent. Tungsten..	2 11
Finished bars, 18 per cent. Tungsten..	3 6
Per lb. delivered buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. per lb.
Rounds and squares under ½ in. to ⅛ in.	3d. ,,
Flats under 1 in. by ⅛ in. to ½ in. by ⅛ in., and all sizes over four times 3 in width and over thickness ..	3d. ,,
Bevels of approved sizes and sections	6d. ,,
If in Coils	3d. ,,
Packing	4s. per cwt
Bars cut to length	10% extra
Scrap from High-Speed Tool Steel—	
Scrap pieces, 5d.	
Turnings and Swarf, 3d.	
Per lb. net, d/d steel-makers' works.	

Ferro-Alloys.

Ferro-Titanium—23/25% Ti. carbonless, 1/5.
Ferro-Tungsten.—75/80%, 2/11.
Ferro-Molybdenum.—70/80%, Mo., 9/6.
Ferro-Vanadium.—35/40%, Va., 26/–.
Metallic-Manganese.—98/99%, carbonless, 3/3. (All per lb.).
Ferro-Phosphorus..—20/25%, P. £18 0 0.
Ferro-Chrome.—4/6%, car., £45 0 0.
Ferro-Chrome.—6/8%, car., £44 0 0.
Ferro-Chrome.—8/10%, car., £42 0 0.
Ferro-Chrome—Specially refined, basis 60% chr., max. 2% car., £130 0 0.
Ferro-Silicon.—45/50% Si., £20 0 0 d/d. at Sheffield Steelworks.
Ferro-Manganese.—80%, £25 loose, £26 0 0 packed. Export £25, according to destination. (All per ton.).

Copper.

	£ s. d.	£ s. d.
Standard cash	98 10 0	99 0 0
Three months	99 0 0	100 0 0
Electrolytic	110 0 0	120 0 0
Tough	107 0 0	109 0 0
Best selected	110 0 0	112 0 0
Sheets	146 0 0	—
India	145 0 0	146 0 0
American electrolytic spot	114 0 0	—
Do. Aug.-Sept. ..	116 0 0	117 0 0
Official average price cash, July ..	99 14 5¼	
Do. Three months, July ..	100 9 2½	
Do. Settlement, July ..	99 13 5½	
Do. Electro, July ..	107 14 9½	
Do. B.S., July ..	102 14 5½	
Average spot price, copper, July ..	99 12 3½	
Do. Electro, July ..	103 8 8½	

Tin.

	£ s. d.	£ s. d.
Cash	271 0 0	272 10 0
Three months ..	267 0 0	267 10 0
English	268 0 0	—
Bars	275 10 0	—
Refined	—	—
Straits	275 0 0	—
Australian.. ..	..	272 0 0
Eastern	..	275 5 0
Banca	..	271 0 0
Official average price, cash, July		253 5 1½
Do. Three months, July		231 13 8½
Do. Settlement, July ..		253 4 1½
Average spot price, July ..		253 5 2½

Spelter.

	£ s. d.	£ s. d.
Ordinary	38 10 0	—
Remelted	39 0 0	42 0 0
Hard	29 0 0	32 0 0
Electro 99.9 ..	45 0 0	47 0 0
English	44 0 0	46 0 0
India	43 0 0	44 0 0
Zinc dust	65 0 0	67 0 0
Do. English ..	—	—
Zinc ashes, per cent. 70%	14 0 0	16 0 0
Official average price, July		42 3 9½
Average spot price, July ..		41 16 8½

Lead.

	£ s. d.	£ s. d.
Soft foreign (net)	24 15 0	
English	26 0 0	
Official average price, July	23 14 2½	
Average spot price, July ..	23 9 1½	

Antimony.

	£ s. d.	£ s. d.
English regulus	42 0 0	
Chinese	40 0 0	to 41 0 0
Crude	38 10 0	
Ore	Nominal.	

Aluminium.

Virgin Metal 98/99— .. .. 150 0 0 per ton.

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II.	—
III., IV., or V.	—
IV. or VII	—
VIII.	—
XI.	—
Cast Strips and Ingots	—
CASTINGS.	Per lb.
I. or II..	—
III., IV. or V.	—
IV. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
,, Cored Bars	—

Delivery 2 Cwt. free to any town.
10 per cent. Phosphor Copper .. £50 above price of best selected copper.
15 per cent. Phosphor Copper .. £70 above price B.S.
Phosphor Tin (5 per cent.) .. .. £30 above price of English Ingots.

Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM.

*Chromium (Metallic).

98/99— purity, per lb. — —

*Nickel.

In cubes, 98/99— purity per ton .. £205 0 0

Nickel Silver.

per lb.

Ingots for raising	—
Ingots for Spoons and Forks ..	—
,, rolled to spoon size ..	—

*Tungsten Metal Powder.

per lb.

96/98— purity 3/4

*Molybdenum Metal.

96/98— purity, per lb .. .. —

*Cobalt Metal.

97— purity, per lb. .. .. .. £ 0 11

Quicksilver.

75 lb. bottle 23 5

* Net, delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	s. d.	s. d.
Steel scrap, heavy melting.. ..	—	—
Iron scrap cast (cupola metal) ..	—	—
(London f.o.b.).		
Heavy steel		120 0
Light ,, ...		80 0
Heavy cast		110 0

Steel Scrap.	Per ton £ s. d.
Without Analysis—	
Heavy steel melting scrap.. ..	6 15 0
Steel planings, turnings and borings	4 15 0
Steel planings, turnings and borings mixed with wrought-iron or other material	4 0 0
Other classes of steel scrap, whether or not mixed	6 5 0
F.o.r. or in barge at nearest siding or wharf.	
With Analysis—	
Heavy steel melting scrap not over 0.04 per cent. p. and s.	7 10 0
Heavy steel melting scrap not over 0.05 per cent. p. and s.	7 5 0

Wrought-Iron Scrap.

	£ s. d.
(1) (a) W.I. plates and sections, not less than ¼ in. thick, reasonably clear of rivets, flanged ends, etc., suitable for shearing · cable scrap and chain scrap not less than ½ in. dia.	7 17 6
(b) Heavy W.I. scrap not less than ¼ in. thick including horseshoes, rivets and bolts, and scrap therefrom	7 17 6
(c) W.I. scrap under ¼ in. thick, and all W.I. scrap not included in classes 1, 2 and 3..	7 17 6
(2) Mixed W.I. scrap	6 7 6
(3) Wrought-iron planings, turnings and borings mixed with steel or other materials	4 2 6
(4) W.I. planings, turnings and borings	4 17 6

Cast-Iron Scrap.

	£ s. d.
Heavy ord., broken, between 1½ cwt. and 10 cwt. each	6 15 0
Heavy machinery, broken between 1½ cwt. and 10 cwt. each.. ..	7 0 0
Cold blast, broken, between 1½ cwt., and 10 cwt.	8 15 0
Ingot mould, unbroken	8 0 0
Do. broken, between 5 cwt. and 2 tons each	8 5 0
Do. between 1½ cwt. and 5 cwt. each	8 10 0
Railway chairs, whole or broken for remelting	7 0 0
Heavy lumps, not exceeding 2 tons each	6 12 6
Light	6 5 0
Burnt, broken ready for cupola ..	5 10 0
Burnt fire bars	6 0 0
Turnings and borings, for iron and steel makers	5 5 0

Old Metal.

London—	£ s. d.
Copper (clean)	90 0 0
Brass (clean)	53 0 0
Lead (less usual draft)	21 10 0
Tea lead	20 0 0
Zinc	25 0 0
New aluminium cuttings	95 0 0
Brazierv copper	75 0 0
Gunmetal	76 0 0
Hollow pewter	180 0 0
Shaped black pewter	120 0 0
(Above all d/d merchant's yard).	

Metallurgical Coke.

Durham and Northumberland—	£ s. d.
Blast furnace	2 8 0
Foundry	2 13 0
Lancs., Staffs., Yorks, Notts., Derbyshire, Lincolnshire and Midland Counties—	
Blast furnace	2 11 0
Foundry	3 5 0

F.o.t. at ovens.

SITUATIONS VACANT AND WANTED.

FOUNDRY MANAGER wanted for London Foundry. Must be a practical moulder, with previous experience of management and in production of general engineering castings, loam and green sand, up to three tons each. Must be well up in cupola practice.—Reply, stating age, experience and salary required to Box 288, FOUNDRY TRADE JOURNAL Office, Bessemer House, Adelphi, Strand, London, W.C.2.

FOUNDRY MANAGER. To reorganise and take charge of old-established Foundry, specialising in small repetition work.—Applicants to state age, experience, and salary required to Box 286, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

FOUNDRY FOREMAN wanted for West Scotland, specialising in Aluminium Castings. Must be experienced, energetic, and have thorough knowledge of the work in all its branches (machine and plate moulding for quick production).—State age, experience and salary required, giving references (in confidence) to Box 284, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

FOUNDRY FOREMAN WANTED. Must be energetic, with sound practical and theoretical knowledge of Foundry work in all its branches, both Malleable and Grey Iron, more especially the former. Repetition work. Good prospects.—Apply, with full particulars salary required, etc., to BULLERS, LIMITED, Tipton Staffs.

MOULDER required to take charge; used to cast-iron air-cooled cylinders; must be able to get efficient production from moulding machines; housing accommodation can be found in the vicinity, N.W. London district.—Apply, stating age, wages required, and particulars of experience to Box No. 282, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2

PATTERN-MAKERS.—Wanted, two or three first-class pattern-makers, accustomed to small work. —Apply, Box No. 278, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

PATTERN-MAKER required to take charge of small shop engaged on small accurate work; London, N.W. district; housing accommodation available in the vicinity.—Apply, stating full particulars of previous employment, age, and wages required to Box No. 280, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

FOUNDRY CHEMIST STEEL MAKER wanted for steel foundry in Spain, experienced in making high-quality castings, tool and alloy steels in the Heroult Furnace.—Apply, in first instance, giving full particulars of experience, age and salary required, to Box No. 292, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, W.C.2.

DRAUGHTSMAN wanted for small works in Lancashire; thoroughly experienced in cupolas, and ladles; one with knowledge of boiler work preferred.—Give references and state age, experience, and renumeration required, to Box 250, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

SITUATIONS VACANT AND WANTED—*cont.*

ENERGETIC and CAPABLE MAN, to take charge of pneumatic moulding machine, "Tabor." Must be expert in machine moulding and up-to-date methods of quick production. Good prospects for right man.—State age, experience, and wages required, to Box No. 276, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

A THOROUGH PRACTICAL FOUNDRYMAN to take up position as Faults Investigator and Scrap Castings Examiner. Good position to an energetic man.—State age, experience, and wages required to Box No. 274, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2

FOR SALE AND WANTED.

WANTING to purchase, secondhand Sand Blast Apparatus, complete with air compressor, receiver, dust collector, and exhaust fan, suitable for a Sand Blast room about 6 ft. to 8 ft. square.—Box No. 248, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

WHEEL TOOTH MOULDING MACHINE, to take boxes 4 ft. dia. x 2 ft. 6 in. under arm, with change wheels complete, balanced mould holder and 40 wheels. 3 Gas Blowing Rotary Fans, coupled direct to steam engine with cylinder about 3½ in. dia. x 5 in. stroke.—Box No. 290, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi. Strand, London, W.C.2.

WANTED.

500 TONS SMALL AGRICULTURAL MACHINE CASTINGS.

Delivery at rate of from 5 to 40 tons per week.
Ref. D., E. H. BENTALL & CO., LTD., Heybridge, Maldon, Essex.

100 TONS of Black Sand wanted quickly, for Foundry in South.—Write, giving quotations, to Box O. 592, Sells, Ltd., 168, Fleet Street, E.C.4.

NOTICE.

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Manresa Road, Chelsea, S.W.3.

DEPARTMENT OF CHEMISTRY AND METALLURGY.

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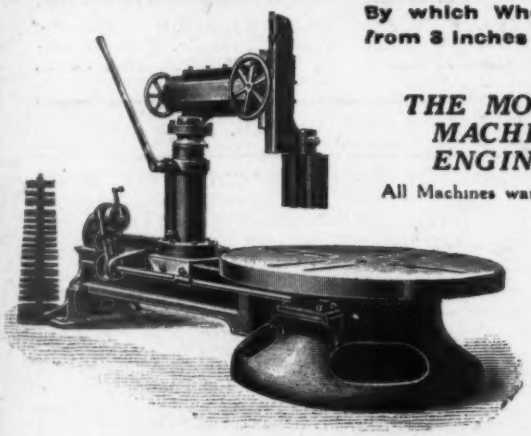

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